ERRATA

The original Appendix B (Comments Revived on the DEIS), had an error while formatting. The EPA public comment on the DEIS was excluded during the formatting process and is not represented in its entirety. The updated Appendix B has the entire comments documented. It is complete and provided for inclusion in this Appendix.

Mississippi Valley Division,
Regional Planning and Environment Division South

Yazoo Backwater Area Water Management Project

APPENDIX B – Comments Received on the Draft Environmental Impact Statement

January 2025

From:
To: YazooBackwater MVK
Subject: [Non-DoD Source] I oppose the Yazoo Pumps & support nature-based flood solutions
Date: Tuesday, August 27, 2024 8:49:51 AM

Dear U.S. Army Corps of Engineers,

As someone who cares deeply about our country's birds, wildlife, and habitats, I am writing to express my strong opposition to the Corps' renewed effort to build the wasteful, ecologically devastating Yazoo Pumps. I urge the Corps to instead pursue a fully nature-based and nonstructural alternative in the Yazoo Backwater Area that can provide effective, environmentally sustainable flood relief for vulnerable communities and birds.

These Mississippi Flyway wetlands are so valuable that the George W. Bush administration vetoed the Yazoo Pumps project in 2008 through the Clean Water Act to protect tens of thousands of acres of nationally important wetlands—a veto that the current administration reasserted. This rare veto explicitly bars the Corps' preferred alternative to build a 25,000 cubic-feet-per-second pumping plant, which will critically degrade the ecological functions of at least 90,000 acres of valuable wetland habitat.

Yazoo backwater communities deserve commonsense flood relief through targeted nature-based and nonstructural solutions that can effectively get people and property out of harm's way, such as elevating homes and roads and compensating farmers to restore cropland to wetlands. Many local community leaders have asked for these 21st-century approaches that would benefit people and wildlife.

I urge the Corps to abandon its misguided efforts to build the Yazoo Pumps and, instead work to advance a fully nature-based and nonstructural flood relief alternative that will protect local communities and hemispherically important wildlife habitat.

Sincerely,

From:
To: YazooBackwater MVK
Subject: [Non-DoD Source] Oppose the Ineffective, Destructive Yazoo Pumps and Employ Proven Nature-Based Flood Relief Solutions, CEMVK-PPMD
Date: Tuesday, August 27, 2024 6:44:42 PM

Dear Colonel Jeremiah A. Gipson,

Dear Colonel Gipson,

I am writing to express my strong opposition to the U.S. Army Corps of Engineers (Corps) renewed effort to build the environmentally devastating agricultural drainage project known as the Yazoo Backwater Pumps.

I ask that you abandon the 2024 plan and eliminate all variations of the Yazoo Pumps once and for all. Instead, I urge the Corps to prioritize effective nature-based and nonstructural flood solutions that truly benefit vulnerable communities and wildlife.

The Yazoo Pumps would be so harmful that the George W. Bush administration vetoed the project in 2008 through the Clean Water Act to protect tens of thousands of acres of nationally important wetlands. It is appalling that the Corps is now proposing a 78% larger Pump that would be the largest hydraulic pump in the world and would drain and damage 90,000 acres of wetlands.

Contrary to the Corps? longstanding claim that the Pumps are the panacea to provide flood protection, your agency?s latest proposal would operate the Pumps based on agricultural planting seasons. This outrageous plan verifies past findings that the Pumps are not designed to protect communities from flooding; rather, 80% of the project benefits come from draining wetlands so agribusiness can make more money.

Further, it?s disturbing that mandatory buyouts through condemnation of residential and commercial properties will be required--most of which are in disadvantaged rural communities. The plan also proposes voluntary buyouts for even more homes and businesses, as well as tens of thousands of acres of farmland.

Communities plagued by flooding in the Mississippi Delta deserve 21st-century safeguards that keep people and property out of harm's way, such as elevating homes and roads and compensating farmers to restore cropland to wetlands. Many local community leaders have asked for these commonsense, nature-based, and nonstructural solutions to benefit people and wildlife. The Corps plan contains none of this.

I urge the Corps to stop its misguided efforts to build this--or any--version of the Yazoo Pumps and, instead, work to advance proven, environmentally sustainable flood risk solutions that will protect local communities and globally important wildlife habitats.

Sincerely,

From: YazooBackwater
To: MVK
Subject: [Non-DoD Source] Protect the Big Sunflower and Yazoo Rivers by dumping the Yazoo Pumps
Date: Wednesday, July 3, 2024 5:14:20 PM

Dear Assistant Secretary Connor, Administrator Regan, and Director Williams,

I oppose the Army Corps' effort to revive the destructive Yazoo Pumps, which would damage tens of thousands of acres of some of the country's most important wetlands. Instead, I ask that the Army Corps, Environmental Protection Agency (EPA), and the U.S. Fish & Wildlife Service (Service) prioritize nature-based and non-structural flood measures that can promptly be implemented to protect local communities and the environment of the Yazoo Backwater Area.

The Big Sunflower and Yazoo Rivers are home to some of the richest wetland and aquatic resources in the nation, and support more than 450 species of birds, fish, and wildlife.

But these rivers are already in crisis. More than 80 percent of wetlands and native forests in the Lower Mississippi alluvial floodplain have already been lost, and the Supreme Court's recent Sackett decision endangers more than half of our nation's remaining wetlands. In addition, agricultural practices and water withdrawals are wreaking havoc on river health. Now is the time to protect the ecologically vital Yazoo Backwater, not to put it at even greater risk.

The Yazoo Pumps project would cost more than $1 billion and do little to protect communities from flooding. Eighty-three percent of the land that flooded during the 2019 flood event would still have been underwater if the Pumps had been in place. Not only would the proposal hurt the environment but the pumps would provide little flood protection for local communities and could worsen downstream flooding in marginalized Black communities.

EPA's Clean Water Act veto of the Yazoo Pumps in 2008 was based on a rigorous analysis of potential impacts and broad public input, and was reasserted by the Biden administration. The veto was issued to permanently block construction of the ecologically destructive Yazoo Pumps—including this revived pumps proposal.

I urgently ask the Army Corps to abandon this and any version of a pumps proposal, and instead ask the Army Corps, EPA, and Fish and Wildlife Service to pursue prompt and effective flood relief that prioritizes nature-based and non-structural measures to protect local communities while conserving vital wetlands that provide natural flood protection and climate resilience.

Sincerely,

From: Melissa Samet <sametm@nwf.org>
Sent: Tuesday, August 27, 2024 6:23 PM
To: YazooBackwater MVK
Subject: [Non-DoD Source] Conservation Organization Yazoo Pumps Comments: Email 1 of 4
Attachments: Conservation Organization Comments_Yazoo Pumps DEIS_Final_08-27-24.pdf

Importance: High

Please see the attached comments on the Draft EIS for the Yazoo Pumps from the National Wildlife Federation, National Audubon Society, Sierra Club, Audubon Delta, Healthy Gulf, and Mississippi Chapter of the Sierra Club.

Due to the large file size of the attachments, I will be sending the text of the comments and Attachments through 4 separate emails. This is email 1 of 4.

I would very much appreciate you confirming receipt of each of the 4 emails.

Thank you.

Melissa Samet
Legal Director, Water Resources and Coasts
National Wildlife Federation
(o) 415-762-8264
(c) 415-577-9193
sametm@nwf.org

Comments on the Draft Environmental Impact Statement for the Yazoo Backwater Area Water Management Project, June 2024

Submitted by

National Wildlife Federation, National Audubon Society, Sierra Club
Audubon Delta, Healthy Gulf, Sierra Club Mississippi

August 27, 2024

Submitted by electronic mail to YazooBackwater@usace.army.mil
Submitted by electronic mail to the Army Corps of Engineers (robyn.s.colosimo.civ@army.mil)
Submitted by electronic mail to the U.S. Environmental Protection Agency (Frazer.Brian@epa.gov)
Submitted by electronic mail to the U.S. Fish and Wildlife Service (james_austin@fws.gov)

TABLE OF CONTENTS

Attachment C:
Multiple Letters from Local Community Members and Leaders Opposing the Yazoo Pumps and Calling for Natural and Nature-Based Measures

Attachment D:
Letters from Conservation, Social Justice, Professional, and Government Organizations Opposing the Yazoo Pumps and Calling for Natural and Nature-Based Measures

Attachment E:
National Audubon Soceity eBird Abundance Analysis

Attachment F:
Multiple Studies Highlighting the Importance of Healthy Wetlands and Connectivity to Fish Species

Attachment G:
Studies Highlighting the Dire Status of Amphibians in the United States and Worldwide

Attachment H:
Letters from Turtle Biologists Regarding the Importance of the Yazoo Backwater Area to turtles, including the Alligator Snapping Turtle

Attachment I:
Email from the Director, Warren County Emergency Management (November 27, 2023)

Attachment J:
William E. Fleenor, Ph.D., Analysis of the HEC-RAS 1D Model Used by the U.S. Army Corps of Engineers in Assessment of their report: "*Impacts of the Yazoo Backwater Pumps to Downstream Stages 22 November 2019*", November 1, 2020; and CV of William E. Fleenor, Ph.D.

The National Wildlife Federation, National Audubon Society, Sierra Club, Audubon Delta, Sierra Club Mississippi, and Healthy Gulf (the "Conservation Organizations") appreciate the opportunity to provide comments on the Corps of Engineers' (Corps) Draft Environmental Impact Statement for the Yazoo Backwater Area Water Management Project dated June 2024 (the "DEIS").

Our organizations steadfastly oppose the proposed 25,000 cubic-foot-per-second (cfs) pumping plant and any other variation of the destructive, dangerous, and costly Yazoo Backwater Pumps and once again call on the Corps to permanently abandon consideration of this and any variation of the Yazoo Pumps.

The Corps should instead support and advance the prompt deployment of the non-structural, natural, and nature-based flood risk reduction solutions outlined in the Conservation Organizations' Resilience Alternative—solutions that have also been requested by many local community leaders, the U.S. Fish and Wildlife Service, the U.S. Environmental Protection Agency (EPA), and many others.

General Comments

The Conservation Organizations steadfastly oppose Alternatives 2 and 3 (Yazoo Pumps Alternatives) and call on the Corps to take these alternatives and all derivations of the destructive, ineffective, and costly Yazoo Pumps off the table once and for all. The Corps should instead advance the deployment of demonstrably effective natural, nature-based and non-structural solutions for the Yazoo Backwater Area, which are included in the Conservation Organizations' Resilience Alternative.[1]

Like every previous derivation of the Yazoo Pumps, the Yazoo Pumps Alternatives would cause unacceptable harm to increasingly rare, hemispherically significant wetlands that cannot be mitigated. These vital wetlands support 450 species of birds, fish, and wildlife; are used by 29 million migrating birds each year[2]; and include tens of thousands of acres of federal, state, and privately-owned conservation lands. These essential wetlands have evolved over millennia as a result of periodic flooding from the Mississippi, Yazoo, and Big Sunflower Rivers and continue to depend on this periodic flooding to thrive.

The Yazoo Pumps Are Prohibited by the Clean Water Act Veto

The Yazoo Pumps Alternatives are prohibited by the Clean Water Act veto[3] because each alternative would damage the critical ecological functions of far more than the 28,400 acres of wetland impacts that trigger applicability of the veto:

[1] The Conservation Organizations have shared this Resilience Alternative with the Corps and other federal agencies on multiple occasions. A copy of this Resilience Alternative is once again provided to the Corps at Attachment A to these comments.

[2] 2020 analyses by the National Audubon Society, using data from eBird Status & Trends from the Cornell Lab of Ornithology and Partners in Flight Population Estimates Database from Bird Conservancy of the Rockies.

[3] Final Determination of The U.S. Environmental Protection Agency's Assistant Administrator for Water Pursuant to Section 404(C) of The Clean Water Act Concerning The Proposed Yazoo Backwater Area Pumps Project, Issaquena County, Mississippi August 31, 2008 (hereafter, the Clean Water Act veto or 2008 Clean Water Act veto).

- Alternative 2 would damage at least **93,306 acres of wetlands**—an area of wetlands twice as large as Washington D.C.; 3.3 times larger than the Clean Water Act veto trigger; and more than 10 times the wetland impacts of all other Clean Water Act vetoed projects combined.[4]

- Alternative 3 would damage at least **89,839 acres of wetlands**—an area of wetlands twice as large as Washington D.C.; 3.2 times larger than the Clean Water Act veto trigger; and more than 9.6 times the wetland impacts of all other Clean Water Act vetoed projects combined.[5]

Notably, as discussed throughout these comments, the adverse impacts to the hundreds of species of fish and wildlife that rely on the Yazoo Backwater Area wetlands will be **much greater** than acknowledged in the DEIS. Indeed, the DEIS fails to assess an extensive array of impacts to those species.

The Yazoo Pumps Alternatives are also prohibited by the Clean Water Act veto because each will have a pumps-on elevation of 91-feet during seven critical months each year—spring migration, breeding seasons, and fall migration. The Clean Water Act veto prohibits a range of operating plans, including a 14,000 cfs pumping plant with a pump-on elevation of 91-feet, including because of the unacceptable impacts of operating below this elevation "during the critical spawning and reading months" in early spring and summer.[6]

The DEIS does **not** include a single reference to the 2008 Clean Water Act veto that was confirmed by the U.S. Court of Appeals for the Fifth Circuit and reasserted by the Biden Administration in November 2021.[7] The DEIS also takes great pains to hide the massive acreage of wetlands that will be damaged by the project. The DEIS Main Report does not provide information on wetland acres damaged. Instead, the information—which confirms the Yazoo Pumps Alternatives would cause significant adverse impacts in violation of the veto—is buried on page 87 of the Wetland Appendix F-3 (Table 53). The Corps also has not provided any information on the extent of wetland damage during the public meetings attended by members of the Conservation Organizations and has not included this information in the project overview slides posted on the Corps' project website.

The Environmental Protection Network (EPN), an organization of over 650 U.S. Environmental Protection Agency (EPA) alumni recently advised EPA Administrator Regan that the Yazoo Pumps Alternatives "would not be allowed under the 2008 Final Determination." Several EPN members who "were actively involved in the development of the 2008 Section 404(c) Final Determination for the Yazoo River Backwater Pumps . . . helped write this letter."[8]

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[4] Exclusive of the wetlands protected by the Yazoo Pumps veto.
[5] Exclusive of the wetlands protected by the Yazoo Pumps veto.
[6] 2008 Clean Water Act veto at 56.
[7] November 17, 2021 letter from EPA Assistant Administrator Radhika Fox to the Acting Assistant Secretary of the Army (Civil Works), Jamie Pinkham.
[8] Environmental Protection Network letter to EPA Administrator Michael S. Regan, August 16, 2024. EPN also notes that "Section 404(c) and the implementing regulations in 40 CFR Part 231 specifically note that a Final Determination issued by the EPA Administrator under Section 404(c) is a final agency action that is then subject to review in the courts. Absent court review, the path for ACOE to take to modify the project is to use the applicable Section 404(c) procedures." EPN also highlighted "that the 2008 Final Determination anticipated and prohibited any similar pump projects located within the Yazoo Backwater Area identified in the Final Determination that would have the same or similar adverse impacts within the project area." A copy of the EPN letter is provided at Attachment B to these comments.

The Yazoo Pumps are Prohibited by the Clean Water Act 404(b)(1) Guidelines
Each of the Yazoo Pumps Alternatives are prohibited by mandatory Clean Water Act 404(b)(1) Guidelines, which strictly prohibit a "discharge into the aquatic ecosystem **unless it can be demonstrated** that such a discharge will not have an unacceptable adverse impact either individually or in combination with known and/ or probable impacts of other activities affecting the ecosystem of concern."[9] The degradation or destruction of wetlands "is considered to be among the most severe environmental impacts covered by" the 404[b)(1) Guidelines.[10] The Yazoo Pumps Alternatives are prohibited by the 404(b)(1) Guidelines because, among other things, these alternatives unquestionably "will cause or contribute to significant degradation of the waters of the United States,"[11] and because there are practicable alternatives that "would have less adverse impact on the aquatic ecosystem."[12]

The Yazoo Pumps are Opposed by Local Community Members and More Than 175 Conservation, Social Justice, Professional, and Local Government Organizations, and Businesses
More than 75 Black community members and leaders are on record as opposing the Yazoo Pumps Alternatives[13] and have repeatedly urged the Corps to "**abandon any version of the Yazoo Pumps**."[14] These residents "have told the Corps over and over again" that they "want effective flood relief through nonstructural and nature-based solutions that honors and respects our underserved communities—not the false promise of the Yazoo Pumps."[15]

These community members also strongly oppose the Yazoo Pumps Alternatives' "mandatory acquisition"—through eminent domain and condemnation—of all structures below the 90-foot elevation (101 structures), including 52 homes in economically disadvantaged communities in the Yazoo Backwater Area[16]:

> On top of pushing another sham version of the Yazoo Pumps onto our communities, you now propose to take our homes and property through eminent domain and condemnation under the shameful perversion of environmental justice. **This is not flood relief, this is a violation of the generational struggles our Black communities have endured in rising up against abuse,**

[9] 40 C.F.R. § 230.1(c) (emphasis added).
[10] 40 C.F.R. § 230.10(d).
[11] 40 C.F.R. § 230.10(c).
[12] 40 C.F.R. § 230.10(a).
[13] This opposition is documented in multiple letters, which are provided at Attachment C to these comments.
[14] Letter from 56 community members, homeowners, and landowners from Sharkey and Issaquena Counties to Assistant Secretary of the Army (Civil Works) Michael Connor and Col. Jeremiah A. Gipson Vicksburg District Commander, August 26, 2024; Letter from 50 community members, homeowners, and landowners from Sharkey and Issaquena Counties to Assistant Secretary of the Army (Civil Works) Michael Connor and Col. Christopher Klein, Vicksburg District Commander, August 4, 2023. These letters are provided at Attachment C.
[15] Id.
[16] Alternatives 2 and 3 also include: voluntary acquisition of residential and commercial properties (231) up to 93.0 feet; voluntary acquisition of up to 11,816 acres of cleared land at or below the 2-year floodplain through fee or a restrictive easement based and additional cleared land up to 93 feet; voluntary acquisition of up to 11,816 acres of cleared land at or below the 2-year floodplain reduced by the amount of compensatory mitigation that "takes place on frequently flooded agricultural lands"; relief wells outside the Yazoo Backwater Area; and changes to the operation of the Steele Bayou flood control gates during low flow conditions.

> **poverty, and injustice**. The legacy of our communities and our families will not be sacrificed to feed the desire of affluent farm owners.[17]

Ty Pinkins, the Founder and President of the Pyramid Project, a non-profit in the Yazoo Backwater Area, has advised both the Corps and the Environmental Protection Agency that the Yazoo Pumps Alternatives are "**unacceptable and offensive**" and "**a slap in the face to Black community members of the Yazoo Backwater Area.**"[18] He also wrote that the decision to move forward with this proposal "casts aside the honest requests many other minority community members and I have made in **asking you to disavow the Yazoo Pumps** and put your energies into providing effective 21st-century flood relief programs and environmental justice resources, especially through nonstructural and nature-based approaches."[19]

The Corps has been aware of this community opposition since at least August 2023, when 50 community members submitted scoping comments urging the Corps "to abandon this and any version of the Yazoo Pumps and to instead work with the Environmental Protection Agency, U.S. Department of Agriculture, and others to quickly implement nature-based and non-structural solutions that can help us recover and thrive."[20] These community members also told the Corps that:

> For decades, the Yazoo Pumps have been held out as the promised solution to flooding in our counties and the rest of Mississippi's Yazoo Backwater Area, but we are not fooled. The Yazoo Pumps will not keep us safe from flooding—the Pumps will simply help enrich large farm owners so they can plant more crops on low-lying lands while our needs and requests continue to be ignored.
>
> The hundreds of millions, and likely billions, of our tax dollars needed to build the pumps would be far better spent on providing meaningful flood relief and economic opportunities to help redress the environmental and other injustices that plague our communities of color. Also, it is outrageous that these same pumps would dump billions of gallons of water downstream, making flooding problems even worse for our mostly Black neighbors in North Vicksburg. Our overlooked communities need effective flood relief now—not the false promise of the Pumps.[21]

In his scoping comments, Mr. Pinkins expressed shock that the Biden Administration would pursue the Yazoo Pumps:

> [Y]our agencies' recent decision to push yet another variation of the Yazoo Pumps is a slap in the face to the communities of color in the Yazoo Backwater. It really is quite shocking that the Biden Administration would propose this project, since its true purpose is to help already rich farm owners get even richer by planting more crops on their large low-lying farms while the

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[17] Letter from 56 community members, homeowners, and landowners from Sharkey and Issaquena Counties to Assistant Secretary of the Army (Civil Works) Michael Connor and Col. Jeremiah A. Gipson Vicksburg District Commander, August 26, 2024. This letter is provided at Attachment C.

[18] Letter from Ty Pinkins, Founder and President of the Pyramid Project (Sharkey County) to EPA Administrator Michael Regan and Regan Assistant Secretary of the Army (Civil Works) Michael Connor, August 26, 2024. This letter is provided at Attachment C.

[19] Id.

[20] Letter from 50 community members, homeowners, and landowners from Sharkey and Issaquena Counties to Assistant Secretary of the Army (Civil Works) Michael Connor and Col. Christopher Klein, Vicksburg District Commander, August 4, 2023. A copy of this letter is provided at Attachment C to these comments.

[21] Id.

needs and requests of Black community members continue to be ignored. Inexcusably, these same pumps will dump billions of gallons of floodwater downstream, making flooding problems even worse for our mostly Black neighbors.

Simply put, the Yazoo Pumps are a blatant environmental injustice. The hundreds of millions, and likely more than a billion, of our tax dollars needed to build the pumps would be far better spent on providing meaningful flood relief and economic opportunities to help redress the environmental and other injustices that plague the Yazoo Backwater Area's Black community members.[22]

The Yazoo Pumps Alternatives are strongly opposed by more than 175 conservation, social justice, faith-based, professional, and local government organizations, and businesses[23,24], including such organizations as:

- The Mississippi River Cities and Towns Initiative (MRCTI), whose membership includes the mayors from the following municipalities in the Mississippi Delta: Vicksburg (MRCTI Co-Chair), Clarksdale, Greenville, Rosedale, and Tunica.

- The Association of State Floodplain Managers, a scientific and educational nonprofit organization dedicated to reducing flood loss in the nation.

- Environmental and social justice organizations, including Mississippi Communities United for Prosperity (MCUP), Mississippi Rising Coalition, the Pyramid Project, ADOS Empowerment Project, Anthropocene Alliance, and many others.

- National, regional, and local conservation organizations, including the League of Conservation Voters, Center for Biological Diversity, Environmental Defense Fund, GreenLatinos, Mississippi River Network, Mississippi River Collaborative, Natural Resources Defense Council, Theodore Roosevelt Conservation Partnership, Waterkeeper Alliance, and many others.

In their scoping comments, the Education, Economics, Environmental, Climate and Health Organization (EEECHO) advised the Corps that the Yazoo Pumps are an "environmental injustice" that would simply "continue the South Delta's long history of prioritizing profits for wealthy farm owners at the expense of Black community members" and would send "more money to Delta farmers while leaving backwater communities unprotected and making flooding problems even worse for predominantly Black neighbors who live downstream." EEECHO also advised the Corps that the "Yazoo Pumps' false promise of flood

[22] Letter from Ty Pinkins, Pyramid Project (Sharkey County) Founder and President to EPA Administrator Michael Regan and Assistant Secretary of the Army Michael Connor, June 2, 2023. A copy of this letter is provided at Attachment C to these comments.
[23] Letter from 139 conservation, social justice, professional, and governmental organizations to EPA Administrator Michael Regan, August 27, 2024. This letter is provided at Attachment D to these comments. A total of 177 organizations signed on to this letter and the letter referenced in footnote 24.
[24] Scoping comments on the Yazoo Backwater Area Pumping Plant (88 Fed. Reg. 43101) submitted by 133 conservation and social justice organizations on August 7, 2023. This letter is provided at Attachment D to these comments. A total of 177 organizations signed on to this letter and the letter referenced in footnote 23.

protection will not redress the long history of environmental injustices and complex hardships faced by South Delta communities."[25]

The DEIS Violates NEPA and other Federal Laws and Policies

The DEIS, upon which the Yazoo Pumps Alternatives are based, violates multiple federal laws and policies. Among many others, the DEIS violates the 2008 Clean Water Act Veto of the Yazoo Pumps. The DEIS violates the National Environmental Policy Act (NEPA), including because the DEIS fails to include a wide array of assessments that must be carried out under NEPA. The DEIS and its Yazoo Pumps Alternatives violate the Clean Water Act 404(b)(1) Guidelines. The DEIS violates the National Environmental Policy Act (NEPA), including because the DEIS fails to include a wide array of assessments that must be carried out under NEPA. The DEIS violates the Water Resources Development Act and Clean Water Act mitigation requirements. The DEIS has not complied with the Water Resources Development Act mandatory independent external peer review requirement. The DEIS and its Yazoo Pumps Alternatives do not conform to the Federal Flood Risk Management Standard. The DEIS has not yet complied with the Endangered Species Act or the Fish and Wildlife Coordination Act.

The DEIS and its Yazoo Pumps Alternatives are fundamentally at odds with the Corps' statutory "long-term goal to increase the quality and quantity of the Nation's wetlands, as defined by acreage and function."[26] The DEIS and its Yazoo Pumps Alternatives are fundamentally at odds with the Administration's Freshwater Initiative which seeks to protect, restore, and reconnect 8 million acres of wetlands and 100,000 miles of our nation's river and streams by 2030.[27] The complete disregard for this goals and policies is all the more unacceptable in light of the nation's alarming increase in wetland losses[28] and the Supreme Court's recent decision in Sackett v. Army Corps of Engineers that has left millions of acres of wetlands without Clean Water Act protection.

Detailed Comments

Fundamental problems with Yazoo Pumps Alternatives and the DEIS are discussed below.

A. The Yazoo Pumps Alternatives Are Prohibited by the 2008 Clean Water Act Veto

Alternatives 2 and 3 (the "Yazoo Pumps Alternatives") are prohibited by the 2008 Clean Water Act veto, which was confirmed by the U.S. Court of Appeals for the Fifth Circuit and properly reasserted by the Biden Administration in November 2021.[29]

Like every previous derivation of the Yazoo Pumps, the Yazoo Pumps Alternatives would cause unacceptable harm to increasingly rare, hemispherically significant wetlands that cannot be mitigated.

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[25] Letter from Ruth Y. Story, EEECHO Executive Director to EPA Administrator Michael Regan and Assistant Secretary of the Army Michael Connor, May 30, 2023. A copy of this letter is provided at Attachment C.
[26] 33 U.S.C. § 2317(a).
[27] The America the Beautiful Freshwater Challenge (April 2024), available at https://www.whitehouse.gov/wp-content/uploads/2024/04/America-the-Beautiful-Freshwater-Challenge.pdf.
[28] Lang, M.W., Ingebritsen, J.C., Griffin, R.K. 2024. Status and Trends of Wetlands in the Conterminous United States 2009 to 2019. U.S. Department of the Interior; Fish and Wildlife Service, Washington, D.C. 43 pp.
[29] This decision put a stop to the previous administration's Yazoo Pumps plan that was opposed by more than 110 scientific professionals, the Society of Wetland Scientists, the Society of Freshwater Science, the North American Lake Management Society, and more than 120 national, state and local conservation, faith-based, social justice, and recreation organizations among many others.

These vital wetlands—which have evolved over millennia due to periodic flooding from the Mississippi and Yazoo Rivers and continue to depend on this periodic flooding to thrive—support 450 species of birds, fish, and wildlife; are used by 29 million migrating birds each year[30]; and include tens of thousands of acres of federal, state, and privately-owned conservation lands.

The 2008 Clean Water Act veto explicitly prohibits degradation of wetland functions on **28,400 or more** acres of wetlands in the Yazoo Backwater Area.[31] Specifically, the veto prohibits degradation of the "ecological functions provided by approximately 28,400 to 67,000 acres of wetlands" in the Yazoo Backwater Area, "including those functions that support wildlife and fisheries resources."[32] The veto confirms the common-sense reality that larger scale impacts are also prohibited: "wetland impacts between approximately 28,400 and 118,400 acres would also result in unacceptable adverse effects on fishery areas and wildlife."[33] The Clean Water Act veto thus prohibits a range of operating plans due to their unacceptable adverse impacts, including a 14,000 cfs pumping plant with a pump-on elevation of 91-feet NGVD.[34]

The Yazoo Pumps Alternatives violate these important prohibitions, thereby causing unacceptable adverse impacts in violation of the Veto. The Environmental Protection Network (EPN), an organization of over 650 U.S. Environmental Protection Agency (EPA) agrees with the Conservation Organizations' assessment. EPN recently advised EPA Administrator Regan that the Yazoo Pumps Alternatives "would not be allowed under the 2008 Final Determination." The authors of this letter included several EPN members who "were actively involved in the development of the 2008 Section 404(c) Final Determination for the Yazoo River Backwater Pumps."[35]

1. The Impacts Are Prohibited by the Clean Water Act Veto

The Yazoo Pumps Alternatives are prohibited by the Clean Water Act veto because each alternative would damage the critical ecological functions of far more than the 28,400 acres of wetlands that trigger applicability of the veto:

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[30] 2020 analyses by the National Audubon Society, using data from eBird Status & Trends from the Cornell Lab of Ornithology and Partners in Flight Population Estimates Database from Bird Conservancy of the Rockies.

[31] The DEIS does **not** include a single reference to this long-standing Clean Water Act veto or this Administration's own decision to reassert that veto.

[32] 2008 Clean Water Act veto at iii.

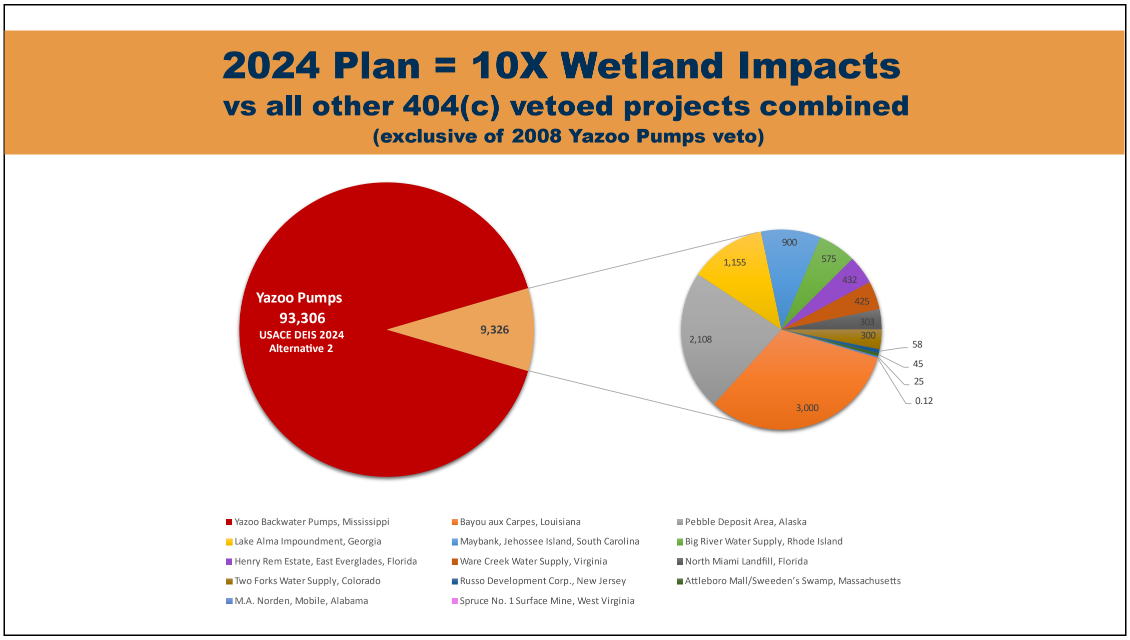
[33] "Although not proposed to go forward, FSEIS Plans 3, 4, and 7, which also include a 14,000 cfs pumping station are expected to result in wetland impacts between approximately 28,400 and 118,400 acres (see FSEIS Main Report, Table 17, page 1-20). EPA has determined that each of these alternatives would also result in unacceptable adverse effects on fishery areas and wildlife." 2008 Clean Water Act veto at iii, 9.

[34] Alternative 7 included a 14,000-cfs pump station with a year-round pumping elevation of 91.0 feet, NGVD. 2007 FSEIS at SEIS-50; Yazoo Backwater Area Reformulation Main Report, October 2007 at 68.

[35] Environmental Protection Network letter to EPA Administrator Michael S. Regan, August 16, 2024. EPN also notes that "Section 404(c) and the implementing regulations in 40 CFR Part 231 specifically note that a Final Determination issued by the EPA Administrator under Section 404(c) is a final agency action that is then subject to review in the courts. Absent court review, the path for ACOE to take to modify the project is to use the applicable Section 404(c) procedures." EPN also highlighted "that the 2008 Final Determination anticipated and prohibited any similar pump projects located within the Yazoo Backwater Area identified in the Final Determination that would have the same or similar adverse impacts within the project area." This letter is provided at Attachment B to these comments.

- Alternative 2 would damage at least **93,306 acres of wetlands**—an area of wetlands twice as large as Washington D.C.; 3.3 times larger than the Clean Water Act veto trigger; and more than 10 times the wetland impacts of all other Clean Water Act vetoed projects combined.[36]

- Alternative 3 would damage at least **89,839 acres of wetlands**—an area of wetlands twice as large as Washington D.C.; 3.2 times larger than the Clean Water Act veto trigger; and more than 9.6 times the wetland impacts of all other Clean Water Act vetoed projects combined.[37]



As documented throughout these comments, the damage from the Yazoo Pumps Alternatives will be far greater than stated in the DEIS. These overlooked impacts further confirm that the proposed alternatives violate the veto.

The adverse implications of the full array of direct and indirect impacts will be amplified by the already highly significant loss and degradation of the wetlands in the Yazoo Backwater Area and the Mississippi Delta. The adverse implications of these already unacceptable adverse impacts will be further amplified by a range of other significant cumulative impacts, including that the Lower Mississippi Alluvial Valley has already lost 80 percent of its original wetlands. The majority of those losses have been traced directly to the effects of federal flood control and drainage projects.[38] From just the 1970s to 2006, the Yazoo Backwater Area lost 11 percent of its remaining forested wetlands.[39] The loss and/or degradation of many tens of thousands of additional acres of wetlands from the Yazoo Pumps Alternatives would

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[36] Exclusive of the wetlands protected by the Yazoo Pumps veto.

[37] Exclusive of the wetlands protected by the Yazoo Pumps veto.

[38] Department of the Interior, The Impact of Federal Programs on Wetlands, Volume I: The Lower Mississippi Alluvial Plain and the Prairie Pothole Region, A Report to Congress by the Secretary of the Interior, October 1988 at 60.

[39] Dahl, T.E., J. Swords and M. T. Bergeson. 2009. Wetland inventory of the Yazoo Backwater Area, Mississippi - Wetland status and potential changes based on an updated inventory using remotely sensed imagery. U.S. Fish and Wildlife Service, Division of Habitat and Resource Conservation, Washington, D.C. 30 p. (available at https://www.fws.gov/wetlands/documents/Wetland-Inventory-of-the-Yazoo-Backwater-Area-Mississippi.pdf).

have catastrophic implications for the ecology of the Lower Mississippi Alluvial Valley and for the fish and wildlife that rely on those resources. For some species, the Yazoo Pumps Alternatives could be the proverbial straw that breaks the camel's back pushing species to or past their tipping points.

Both alternatives also include multiple low flow wells located outside the Yazoo Backwater Area measures and modifications to the operation of the Steele Bayou Water Control Structure, which DEIS says will reduce environmental impacts.[40] However, EPA identified "extensive deficiencies regarding the installation of such wells" and rejected the addition of such wells as a basis for sidestepping the 2008 Clean Water Act veto.[41] The Conservation Organizations also provided extensive, detailed comments on the inappropriateness of using such wells—including because the use of such wells are counterproductive, will not reduce environmental impacts, and cannot be used as a form of mitigation under the strict requirements applicable to the use of out-of-kind mitigation—in comments on the 2020 Yazoo Pumps DSEIS.

The Conservation Organizations agree that environmental benefits would be achieved by modifying the operation of the Steele Bayou Water Control Structure to allow water levels to reach 75.0 feet in the Yazoo Backwater Area before the gates are closed[42], that modification can—and should be—carried out as an independent action. That modification is not related to, and is not dependent on, construction and operation of the Yazoo Pumps Alternatives.

As discussed in Section L of these comments, the significant adverse impacts of the Yazoo Pumps Alternatives will not be offset by the mitigation proposed in the DEIS and likely cannot be meaningfully offset by any amount of mitigation.

2. The Operating Plans Are Prohibited by the Clean Water Act Veto

The Clean Water Act veto prohibits a range of operating plans, including a 14,000 cfs pumping plant with a pump-on elevation of 91-feet NGVD. The veto documents the unacceptable adverse impacts of operating the proposed pumps "during the critical spawning and reading months" in early spring and summer.[43] "Spring flooding is the major factor responsible for fishery productivity within the Yazoo River Basin."[44] It is also critical to many bird species that depend on the Yazoo backwater area. EPA thus vetoed the proposed operating plans because they would have reduced "the extent and duration of the spring flood pulse [which] would severely reduce the current fish productivity of the lower Yazoo Basin."[45] That "reduction in the extent and duration of the spring flood pulse" would also "result in significant adverse impacts to those birds which not only utilize the Yazoo Basin, but are dependent upon backwater flooding during these periods."[46] EPA also documented how a decline in the spring flood pulse would have long-term effects throughout the year, explaining that "the reductions in spring

[40] DEIS, Main Report at 32-34.
[41] November 17, 2021 letter from EPA Assistant Administrator Radhika Fox to the Acting Assistant Secretary of the Army (Civil Works), Jamie Pinkham at 23; *see also* EPA November 30, 2020 Comment Letter on 2020 DSEIS, Enclosure, at 5-6.
[42] DEIS, Main Report at 32-34.
[43] 2008 Clean Water Act veto at 56.
[44] 2008 Clean Water Act veto at 56.
[45] 2008 Clean Water Act veto at 56.
[46] 2008 Clean Water Act veto at 58.

flooding [would] ultimately, over time, alter the flora and fauna that waterfowl depend on during the breeding and wintering period."[47].

The veto prohibits the Yazoo Pumps Alternatives, which propose a significantly larger 25,000 cfs pumps with a pump on elevation *below* 91 feet during the critical spring breeding and rearing season. In fact, the massive 25,000 cfs pumps would be operated to keep water levels below the 90-foot elevation for seven critical months each year—throughout the entire spring migration, fall migration, breeding, and rearing seasons for the hundreds of species that rely on the Yazoo Backwater Area wetlands. As a result, the pumps would operate below the 91-foot elevation level that also triggers applicability of the veto:

- Alternative 2 would operate a 25,000 cfs pumping plant with a pumps-on elevation at or **below 90 feet** for 7 months (214 days) each year to **benefit industrial-scale agriculture** in the Yazoo Backwater Area.

- Alternative 3 would operate a 25,000 cfs pumping plant with a pumps-on elevation at or **below 90 feet** for 6 months and 21 days (205 total days) each year to **benefit industrial-scale agriculture** in the Yazoo Backwater Area.

The DEIS shows that the pumps would be turned on when water levels are below 91 feet at least 82% of the time that they are used (18 out of the 22 times that the pumps would have been used over the period of record analyzed in the DEIS). Because the Yazoo Pumps Alternatives have a 78% larger pumping capacity than the 14,000 cfs pumping plant analyzed in the Clean Water Act veto, the Yazoo Pumps Alternatives will cause far more harm to wetland functions.

The Corps has made much of the fact that its operating plan was designed to reduce flood risks while reducing environmental impacts. But the proposed operating plans miss the point of the veto as those plans fail to address the unacceptable adverse impacts of operating the pumps during the spring breeding and rearing season. Indeed, instead of avoiding those impacts, the Corps has made the problem worse by proposing to operate significantly larger 25,000 cfs pumps during this critical timeframe.

The Conservation Organizations also point out that proposed operating plans are focused entirely on benefitting industrial-scale agriculture as pumping below the prohibited 90-foot elevation—i.e., below the 2-year floodplain—is triggered by crop season. Indeed, the only difference between the operating plans for Alternatives 2 and 3 is a slight variation on the crop-season start date. During non-crop season, water levels will be allowed to reach the 93-foot elevation—i.e., the 5-year floodplain.

As documented in the DEIS, even small changes in the operating regime can translate into significant additional harm. For example, Alternative 2 includes 9 extra days of pumping below the 90-foot elevation as compared to Alternative 3. But these 9 extra days result in **an additional 3,467 acres** of wetland damage.[48]

If the operating plan does change, project-induced impacts could increase well above the already unacceptable levels currently identified in the DEIS. This is a very real risk, including because the Corps

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[47] 2008 Clean Water Act veto, Appendix 1 at 61.
[48] DEIS Main Report and Wetland Appendix F-3 at 87, Table 53.

has not provided an actual operating plan in the DEIS, leaving the public with no ability to assess the actual impacts of that plan—which like most Corps operating plans will likely include options for multiple deviations from the plan's typical parameters.

As importantly, operating plans can—and typically do—change over time. Indeed, the Corps' regulations require the Corps to "keep approved water control plans up to date" including by subjecting those plans "to continuing and progressive study by personnel in field offices of the Corps of Engineers."[49]

The Corps' Engineering Regulations also direct that water control plans should be reviewed "no less than every 10 years and **shall be revised as needed** in accordance with this regulation."[50] Those regulations also state that the development of water control plans "continues as new information becomes available during project implementation" and that water control plans "will be revised as necessary to conform with changing requirements resulting from developments in the project area and downstream, improvements in technology, improved understanding of ecological response and ecological sustainability, new legislation, reallocation of storage, new regional priorities, changing environmental conditions and other relevant factors."[51]

The Corps' Engineering Regulations also contemplate **recurring deviations from operating plans**. For example, instead of prohibiting deviations, the Corps' Engineering Regulations state that deviations "that impact the fulfillment of authorized purposes, that occur in three or more consecutive years, or that occur more than three times within a five-year period must be fully coordinated with CECW-CE."[52] Indeed, the regulations allow "[s]ignificant, recurrent or prolonged deviations from operations prescribed by an approved water control plan" unless the division commander decides that such deviations "indicate a need for a formal change to operations prescribed by an approved water control plan."[53]

Importantly and disturbingly, there is **<u>no</u>** requirement to notify the resource agencies or the public of any such deviations. It will also be difficult—and possibly impossible—for resource agencies or the public to know whether the Corps is in fact following the operating plan or deviating from it during a particular flood event.

As a result, the operating plan for the selected alternative cannot provide a reliable backstop for managing environmental harm or selecting the least environmentally damaging practicable alternative, as required by the Clean Water Act. To the contrary, a Yazoo Pumps operating plan (or modified operating plan) may well be fleeting, unreliable, and unenforceable.

There are numerous examples of the Corps changing operating plans. For example, the Corps recently finalized an update to the water control plan for Lake Okeechobee.[54] While Congress directed the Corps

[49] 33 CFR 225(f)(2).
[50] ER 1110-2-240, Water Control Management (30 May 2016) at paragraph 3-2j (emphasis added).
[51] ER 1110-2-240, Water Control Management (30 May 2016) at paragraph 3-2j.
[52] ER 1110-2-240, Water Control Management (30 May 2016) at paragraph 3-2j.
[53] ER 1110-2-240, Water Control Management (30 May 2016) at paragraph 3-2j.
[54] USACE Press Release, USACE South Atlantic Division Commander Signs LOSOM Record of Decision (August 13, 2024)(available at https://www.saj.usace.army.mil/Media/News-Releases/Article/3870842/usace-south-atlantic-division-commander-signs-losom-record-of-decision/).

to expedite this update in the Water Resources Development Act of 2018,[55] Congressional direction is neither required nor expected.

The New Madrid Floodway provides another example, where the operating plan for activating the New Madrid Floodway to reduce flood stages on the Mississippi River has changed significantly over time, without Congressional direction. When initially authorized in 1928, the floodway was to be activated when water levels were predicted to reach 55 feet at Cairo, Illinois. This activation level was increased to 60 feet in the Flood Control Act of 1965. The Corps raised the activation level to 61 feet in 1968 by modifying the operating plan. These changes helped protect agricultural production in the floodway at the expense of public safety and the environment.

In 2011, the Corps chose not to follow the operating plan but instead waited until water levels reached 61.72 feet before activating the floodway. This was far above both the authorized activation level and the 1986 activation level. This delay occurred even though the Corps had extensive advance notice of the flood threat.[56] The delay was due in large part to a lawsuit filed by the state of Missouri to stop the floodway's use. "Missouri officials had fought hard to stop the plan, filing court actions all the way to the U.S. Supreme Court."[57] While Missouri eventually lost its legal challenge, critical time was lost as the legal battle played out in court.

The delay in activating the floodway resulted in extensive flooding. More than 200 structures flooded in Olive Branch, Illinois. Almost 240 homes were flooded in the City of Metropolis, Illinois, and dozens of businesses were either closed or greatly affected by high water. Lost revenue, flood fighting and clean-up costs from the 2011 flood cost Metropolis almost $1.4 million.[58] The entire City of Cairo, Illinois, was put under a mandatory evacuation order. Residents were forced to leave their homes and find alternative places to stay. Cairo could have been destroyed by any further delay. Once the floodway was used, water levels at Cairo dropped 1 foot in just 6 hours, and 2.7 feet in just 48 hours.

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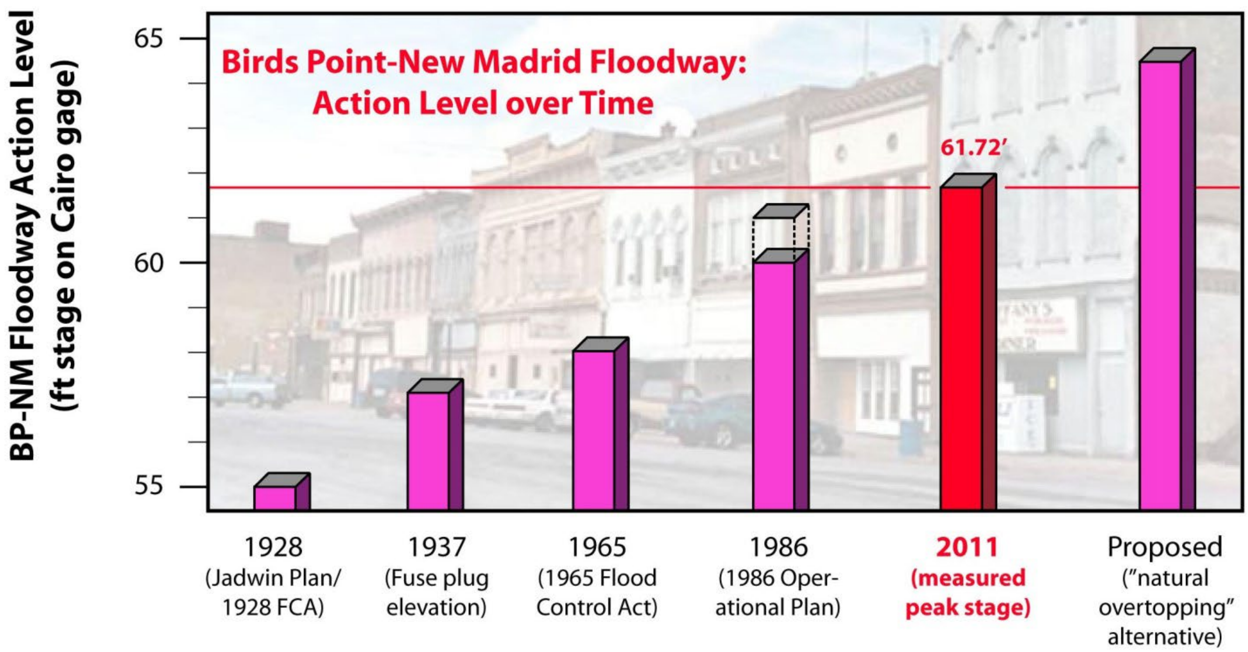
[55] Water Resources Development Act of 2018, Section 1106 ("The Secretary shall expedite completion of the Lake Okeechobee regulation schedule to coincide with completion of the Herbert Hoover Dike project, and may include all relevant aspects of the Comprehensive Everglades Restoration Plan described in section 601 of the Water Resources Development Act of 2000 (114 Stat. 2680).").

[56] Camillo, Charles A., "Divine Providence: The 2011 Flood in the Mississippi River and Tributaries Project" (2012). *US Army Corps of Engineers, Omaha District.* Paper 142 at 93-94, available at http://digitalcommons.unl.edu/usarmyceomaha/142) (visited on December 18, 2016). On April 30, the National Weather Service had predicted that the flood stage at Cairo would reach 61.5 feet by May 4. On May 1, the river level at Cairo had surged past 59.5 feet. However, the floodway was not activated (by blowing up the Bird's Point levee) until the river had reached 61.72 feet at Cairo. The floodway was activated on May 2, 2011 at approximately 10 pm EST.

[57] CBS St. Louis, http://stlouis.cbslocal.com/2011/05/03/watch-blowing-up-birds-point-levee/ (visited on November 24, 2013).

[58] July 26, 2016 Letter to President Obama from Billy McDaniel, Mayor of the City of Metropolis, Illinois.



Action Level Chart Courtesy of Nicholas Pinter, Ph.D., Southern Illinois University

The Yazoo Pumps have already been the subject of intense political pressure. Indeed, this pressure appears to have been a driving factor in this latest reassessment of the Yazoo Pumps, despite the Administration's own November 17, 2021, letter reasserting the project's long-standing Clean Water Act veto.

Indeed, the Corps has already responded to pressure to lengthen the amount of time of the crop-season operating period. As documented in the DEIS, the Corps has proposed Alternative 2 in response to a push from the agricultural community during the May 2023 public engagement meetings."[59] Alternative 2 initiates crop-season operations 9 days earlier than the alternative originally proposed by the Corps resulting in an **additional 3,467 acres** of wetland damage. Agricultural producers continue to pressure the Corps to make additional extensive changes to the operating plan, as made clear during the July 22-23 public meetings on the DEIS.[60]

The pressure to operate the pumps for longer periods of times and with lower pumps-on elevations continues, as was made clear during the 2024 public meetings on the Draft EIS. For example, at the July 23, 2024, 2:00 PM public meeting, members of the public called on the Corps to pump all year long[61] and set the pump-on elevation even "lower."[62] Indeed, the Corps explicitly solicited comments on extending the crop season through November at the July 23, 2024, 2:00 PM DEIS public hearing:

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[59] DEIS, Main Report at 25.

[60] Recordings of these public meetings can be accessed from the Corps' website at https://www.mvk.usace.army.mil/Missions/Programs-and-Project-Management/Yazoo-Backwater/.

[61] See, e.g., Will Rutherford, farmer south of Rolling Fork, MS July 23, 2024, 2:00 PM public meeting video recording 1:06:29-1:07:23. The Corps has not provided transcripts of the public meetings.

[62] See, e.g., Diane Klause, resident of Eagle Lake, MS July 23, 2024, 2:00 PM public meeting video recording 1:00:38 -1:00:54. The Corps has not provided transcripts of the public meetings.

"So here we get into our array of alternatives…we also look at two operational scenarios. One Alternative 2 and then Alternative 3, we're going to dive deeper into these in a second, but I'll give you a little overview. Really the difference between Alternative 2 and Alternative 3 is the growing season of the crop. Alternative 2 the crop season is 16 March through 15 October, and non-crop season of 16 October through 15 March. That's tied to elevations of when the pump could be on if there are floodwaters. We'll get into that a little deeper. **But one thing that I really hope I hear comments from you guys on this is my background is agricultural economics, so I understand you guys as farmers if you grow cotton, cotton usually goes past 15 October, maybe up until November when you're harvesting after you defoliated, and go through, um, those spells. So, um, we did hear some testimony that people weren't as concerned about floodwaters in October, because it's extremely rare to see floods in the fall like that but it's something to consider and we welcome your comments on that**."[63]

For all these reasons, the DEIS at a minimum must assess the impacts of the Yazoo Pumps Alternatives under an appropriate range of possible operating plans so decision makers and the public can properly assess the full extent of the environmental damage that could result from building the massive 25,000 cfs Yazoo Pumps. See Section C.7 of these comments for additional information on this important point.

B. The Yazoo Pumps Alternatives are Prohibited by the Clean Water Act 404(b)(1) Guidelines

In addition to being prohibited by the Clean Water Act 404(c) veto, the Yazoo Pumps Alternatives are prohibited by the Clean Water Act 404(b)(1) Guidelines. The 404(b)(1) Guidelines strictly prohibit a "discharge into the aquatic ecosystem **unless it can be demonstrated** that such a discharge will not have an unacceptable adverse impact either individually or in combination with known and/ or probable impacts of other activities affecting the ecosystem of concern."[64] The "degradation or destruction of special aquatic sites, such as filling operations in wetlands, is considered to be among the most severe environmental impacts covered by the[] Guidelines."[65] These Guidelines are binding and are explicitly applicability to water resources projects planned or constructed by the Corps.[66]

The Yazoo Pumps Alternatives are prohibited because:

(1) They Will Contribute to Significant Degradation of Waters of the United States

The 404(b)(1) Guidelines prohibit discharges that "will cause or contribute to significant degradation of the waters of the United States."[67] The Yazoo Pumps Alternatives will unquestionably contribute to significant degradation, and thus are prohibited. As discussed above, the DEIS acknowledges that Alternative 2 would damage at least **93,306 acres of wetlands and Alternative 3 would damage at least 89,839 acres of wetlands.** As also discussed above, it its 2008 Clean Water Act, EPA already determined

[63] Brandon Davis, Environmental Planning Chief for the Corps' Vicksburg District July 23, 2024, 2:00 PM public meeting video recording 19:10-20:30. The Corps has not provided transcripts of the public memeetings,o these quotes were transcribed by the Conservation Organizations.
[64] 40 C.F.R. § 230.1(c) (emphasis added).
[65] 40 C.F.R. § 230.10(d).
[66] 33 CFR § 336.1(a); *See* All. to Save the Mattaponi v. U.S. Army Corps of Engineers, 606 F. Supp. 2d 121, 124 (D.D.C. 2009) (Stating that "the Corps must follow binding guidelines established by the Corps and the EPA (the "Guidelines" or the "404(b) Guidelines"), which are codified at 40 C.F.R. Part 230.").
[67] 40 C.F.R. § 230.10(c).

that impacts at this scale would cause unacceptable adverse impacts to hemispherically significant wetlands. Notably, EPA has used its veto authority sparingly to stop only those projects that would cause the worst of the worst impacts.

(2) They Are Not the Least Environmentally Damaging Practicable Alternative

The 404(b)(1) Guidelines prohibit a discharge unless it has been clearly demonstrated that there is no "practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem." 40 C.F.R. § 230.10(a). The Corps has not—and cannot—demonstrate that the Yazoo Pumps Alternatives are the least environmentally damaging practicable alternative. See Sections M and N of these comments. As a result, the Yazoo Pumps Alternatives are prohibited.

The Corps continues to disregard practicable, less-damaging alternatives repeatedly proposed by EPA, the U.S. Fish and Wildlife Service, Yazoo Backwater Area community leaders, the conservation community, and the public. As the Corps is aware, the Conservation Organizations developed, and continue to advocate for, the use of a highly practicable Resilience Alternative in lieu of the Yazoo Pumps. This Resilience Alternative and Information for prioritizing the use of the measures included in the Resilience Alternative are provided again at Attachment A. The measures included in the Resilience Alternative are demonstrably effective and demonstrably practicable and would avoid the incredibly destructive and dangerous impacts of the Yazoo Pumps Alternatives or any other derivation of the Yazoo Pumps, as discussed in Section M of these comments.

(3) They Will Contribute to Violations of State Water Quality Standards

The 404(b)(1) Guidelines prohibit a discharge that will cause or contribute to violations of state water quality standards.[68] As discussed in Section J and Section A of these comments, the Yazoo Pumps Alternatives will cause or contribute to violations of state water quality standards, including the state's anti-degradation policy[69] and the many TMDLS for stream segments located within the Yazoo Backwater Area.

(4) They May Jeopardize the Continued Existence of the Federally Endangered Pondberry

The 404(b)(1) Guidelines prohibit a discharge that jeopardizes the continued existence of species listed as endangered or threatened under the Endangered Species Act.[70] As of 2020, there were 62 distinct pondberry colonies in the Yazoo Backwater Area, including 50 on the Delta National Forest and 12 on private lands in Bolivar and Sunflower counties. As discussed in Section I of these comments, the Corps has not finalized the required formal consultation on the pondberry or the other listed species in the Yazoo Backwater Area. The Yazoo Pumps Alternatives will be prohibited by the 404(b)(1) Guidelines it the pumps would jeopardize the continued existence of the pondberry or other listed species.

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[68] 40 C.F.R. § 230.10(b).

[69] *See* https://www.mdeq.ms.gov/wp-content/uploads/2007/10/yzmap&tablewqsadptaug07.pdf (Map depicting Yazoo River Basin Water Quality Standards).

[70] 40 C.F.R. § 230.10(b).

(5) "Appropriate and Practicable" Steps Have Not Been Taken to Minimize Adverse Impacts

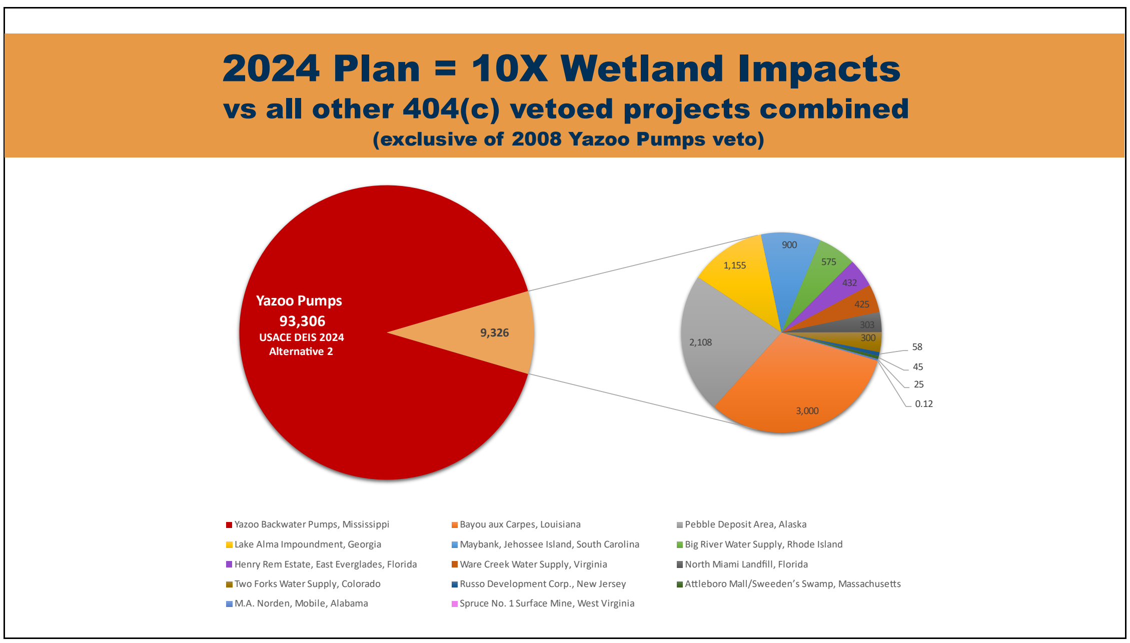
The 404(b)(1) Guidelines prohibit a discharge unless "appropriate and practicable" steps have been taken to minimize potential adverse impacts on the aquatic ecosystem.[71] As discussed in Sections L, M, and N of these comments—and as noted throughout these comments—the Corps has not taken appropriate and practicable steps to minimize the adverse impacts from the Yazoo Pumps Alternatives.

C. The DEIS Significantly Understates the Ecological Implications of the Acknowledged Wetland Impacts, and Likely Underestimates the Spatial Extent of Wetland Impacts

As documented above, the DEIS fully acknowledges that the Yazoo Pumps Alternatives will cause a minimum of **89,839** to **93,306** acres of wetland impacts—impacts that unquestionably are prohibited by the longstanding 2008 Clean Water Act veto.

- Alternative 2 would damage at least **93,306 acres of wetlands**—an area of wetlands twice as large as Washington D.C.; 3.3 times larger than the Clean Water Act veto trigger; and more than 10 times the wetland impacts of all other Clean Water Act vetoed projects combined.[72]

- Alternative 3 would damage at least **89,839 acres of wetlands**—an area of wetlands twice as large as Washington D.C.; 3.2 times larger than the Clean Water Act veto trigger; and more than 9.6 times the wetland impacts of all other Clean Water Act vetoed projects combined.[73]



However, the DEIS clearly understates the ecological implications of the wetland impacts, including by failing to properly assess lost wetland functions and failing to assess impacts to wetland plant species,

[71] 40 C.F.R. § 230.10(d).
[72] Exclusive of the wetlands protected by the Yazoo Pumps veto.
[73] Exclusive of the wetlands protected by the Yazoo Pumps veto.

among many other things. The DEIS also likely understates the spatial extent of wetland impacts and thereby overlooks additional impacts that further demonstrate the Yazoo Pumps Alternative are unquestionably prohibited by the Clean Water Act veto.

Understanding the full extent of wetland impacts is critically important because the Yazoo Pumps would drain an area that:

> contains some of the richest natural resources in the nation including a highly productive floodplain fishery, one of only a few remaining examples of the bottomland hardwood forest ecosystem which once dominated the Lower Mississippi Alluvial Valley, and is one of only four remaining backwater ecosystems with a hydrological connection with the Mississippi River."[74]

Forested wetlands have long been recognized as vitally important and as being "among the Nation's most important wetlands."[75]

As the 2008 Clean Water Act veto makes clear, construction and operation of the Yazoo Pumps "would dramatically alter the timing, and reduce the spatial extent, depth, frequency, and duration of time that wetlands within the project area are inundated."[76] The ecological implications of these changes are enormous, because hydrology is "the single most important determinant of the establishment and maintenance of specific types of wetlands and wetland processes."[77]

Among many other things:

> Hydrology affects species composition and richness, primary productivity, organic accumulation, and nutrient cycling in wetlands. . . . Water depth, flow patterns, and duration and frequency of flooding, which are the result of all the hydrologic inputs and outputs, influence the biochemistry of the soils and are major factors in the ultimate selection of the biota of wetlands. . . . the hydrology of a wetland directly modifies and changes its physiochemical environment (chemical and physical properties), particularly oxygen availability and related chemistry, such as nutrient availability, pH, and toxicity (e.g., the production of hydrogen sulfide). Hydrology also transports sediments, nutrients, and even toxic materials into wetlands, thereby further influencing the physiochemical environment. . . . Hydrology also causes water outflows from wetlands that often remove biotic and abiotic material, such as dissolved organic carbon, excessive salinity, toxins, and excess sediments and detritus."[78]

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[74] U.S. Fish and Wildlife Service, Fish and Wildlife Coordination Act Report (October 23, 2006), 2007 Final SEIS, Appendix 3 at 1.

[75] Report to Congress, Secretary of the Interior, Impact of Federal Programs on Wetlands, 1988, Volume I at 39.

[76] Clean Water Act 404(c) Final Determination at i.

[77] William J. Mitsch and James G. Gosselink, *Wetlands* (5th ed.) (2015) at 112 (emphasis in original).

[78] Id. at 111-112.

Critically, even small alterations in wetland hydrology can produce significant, ecosystem-wide changes, as the seminal textbook on wetlands makes clear:

> **When hydrologic conditions in wetlands change even slightly, the biota may respond with massive changes in species composition and richness and in ecosystem productivity.**[79]

Wetlands maintained by overbank flooding are particularly productive: "Pulse-fed wetlands are often the most productive wetlands and are the most favorable for exporting materials, energy, and biota to adjacent ecosystems."[80] The Corps recognizes that pulse-fed riverine wetlands provide at least three critical functions (detaining floodwater, exporting organic carbon, and removing elements and compounds) that are not provided by non-riverine wetlands.[81] Riverine wetlands provide essential habitat for many species of fish and wildlife, including critical spawning habitat.[82] The hydrological cycle of overbank flooding that is well recognized as being "critically important to maintenance of project-area wetland and aquatic habitat values, including fisheries production" and that provides the biochemical link to the rest of the lower Mississippi Alluvial Valley ecosystem.[83]

Understanding the full spatial extent of wetland impacts and full extent of impacts to wetland functions is fundamental to understanding the full extent of impacts from the Yazoo Pumps Alternatives, including because the Yazoo Pumps Alternatives would diminish the hydrologic cycle that produces overbank flooding throughout the year. If the DEIS understates wetland impacts, those flaws infect the entire impacts analysis and magnify the unreliability of the DEIS.

The Conservation Organizations note that the DEIS analysis of wetland impacts, and thus the entire DEIS impacts analysis, is based on the hydrologic modeling discussed in the DEIS Engineering Report.[84] Despite the foundational and fundamental role of this modeling in the DEIS, the Engineering Report provides relatively little information to explain the model or its outputs.

Consequently, the Conservation Organizations were compelled to request the underlying model, model inputs, and model outputs through the Freedom of Information Act. Despite two such requests[85], and

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[79] Id. at 112 (emphasis added).
[80] Id. at 119.
[81] USACE Engineer Research and Development Center, A Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing Functions of Forested Wetlands in the Mississippi Alluvial Valley, ERDC/EL TR-13-14 (July 2013) (hereafter, "2013 HGM Regional Guidebook") at 27. This HGM Guidebook assigns 6 functions to pulse-fed wetlands with a return interval of 5 years or less (detain floodwater, export organic carbon, detain precipitation, cycle nutrients, maintain plant communities, and provide fish and wildlife habitat), but assigns just 4 functions to non-riverine wetlands (detain precipitation, cycle nutrients, maintain plant communities, and provide fish and wildlife habitat). The Corps' 2002 HGM Guidebook, developed for the Yazoo Pumps project, assigns a third function that is only supplied by pulse-fed riverine wetlands (remove elements and compounds). USACE Engineer Research and Development Center, *A Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing Wetland Functions of Selected Regional Wetland Subclasses, Yazoo Basin, Lower Mississippi River Alluvial Valley*, ERDC/EL TR-02-4 (April 2002).
[82] See, e.g. Clean Water Act 404(c) Final Determination, Technical Appendices.
[83] U.S. Fish and Wildlife Service, Fish and Wildlife Coordination Act Report (October 23, 2006), 2007 Final SEIS, Appendix 3 at 11.
[84] DEIS, Appendix A Engineering Report.
[85] The first FOIA request for the models was submitted by the National Wildlife Federation on May 16, 2024. Earthjustice submitted a second FOIA request for the same information on behalf of Healthy Gulf on June 28, 2024.

repeatedly asking the Corps to expedite production of the requested data, the requested information was not provided in an accessible form until August 2, 2024. As a result, the Conservation Organizations have not had time to fully assess the assess the model and its results. If appropriate, the Conservation Organizations will provide additional comments on this model when our review is completed.

1. The DEIS Does Not Utilize the Appropriate Period of Record for Determining Flood Frequency and Wetland Classification

As highlighted in the Corps' own 2013 HGM Regional Guidebook, the Corps should establish the riverine wetland baseline by using flood frequency conditions present in the mid-twentieth century (i.e., the 1950s) for categorizing wetland classes, for determining flow frequencies, and for assessing wetland impacts (including loss of functionality):[86]

> As with the classification system, flood frequencies established as a result of the major river engineering projects in the mid-twentieth century are considered to be the baseline condition in most assessment scenarios.[87]

As a result, the Corps should not rely on changes to flood frequencies, inundation patters, or wetland classification criteria resulting from construction and operation of the Yazoo Backwater Levee (completed in 1978), the Steele Bayou water control structure; (completed in 1969), Little Sunflower River water control structure (completed in 1975), and Muddy Bayou water control structure (completed in 1978) or other post-1950s Yazoo Backwater Area flood projects. Riverine wetlands that were subject to flooding once every 5-years on average and that otherwise met the wetland definitional criteria **prior to these more recent flow alteration projects must still be categorized as riverine wetlands for purposes of assessing impacts, even if wetlands are degraded**.

Fully assessing the adverse impacts to the riverine class of wetlands is essential as those wetlands provide an array of critical functions not provided by other wetland classes, as discussed below. Impacts to riverine wetlands are also particularly difficult to mitigate, as recognized by the Corps:

> "Creation of riverine wetlands is difficult because rivers are highly integrated into existing landforms. Geomorphic features in particular may have required millennia to develop. Consequently, compensatory mitigation for degradation of riverine wetland functions seldom can be accomplished by creating new ones given the scarcity of appropriate sites."[88]

The DEIS fundamentally ignores its own HGM Regional Guidebook, choosing instead to rely on flood frequencies based on a period of record that begins in 1978—after completion of each of the large-scale projects highlighted about that individually and collectively fundamentally altered hydrologic conditions and flood frequency elevations. Indeed, the flood frequency elevations used in the DEIS are significantly lower than the ones used in the 2007 EIS:

Earthjustice received a hard drive from the Corps with what was supposed to be responsive information on July 30, 2024. However, the information on the hard drive could not be accessed. The Corps then sent Earthjustice the files electronically, with the full set of files finally being received on August 2, 2024.

[86] 2013 HGM Regional Guidebook at 61.

[87] 2013 HGM Regional Guidebook at 61.

[88] Brinson, M.M., et al. 1995. A Guidebook for Application of Hydrogeomorphic Assessments to Riverine Wetlands. Wetlands Research Program Technical Report WRP-DE-11 at 7.

- The 2-year (50 percent ACE) floodplain elevation is 89.3-feet-NGVD.[89] This is 1.64-feet-NGVD lower than the 91-foot-NGVD 2-year floodplain elevation in the 2007 EIS.[90]

- The 5-year (20 percent ACE) elevation is 92.0-feet-NGVD.[91] This is 2.6-feet-NGVD lower than the 94.6-foot-NGVD 5-year floodplain elevation in the 2007 EIS.[92]

Relying on this new flood frequency elevations has the effect of reducing the number of acres categorized as "riverine wetlands" which in turn will result in a showing of fewer wetland impacts because of the Yazoo Pumps Alternatives.

The Conservation Organizations also note that it is essential that the DEIS utilize accurate flood frequency elevation levels consistently for all analyses in the DEIS. Accurate and consistent stage elevations are essential for multiple analyses, including the assessment of wetland and stream impacts, project need, project benefits, and mitigation feasibility and costs. If the flood frequency elevations are lower now than they were in 2007, those reductions will have resulted in adverse impacts to Yazoo Backwater Area streams, wetlands, and wildlife that must be fully accounted for including through a meaningful assessment of cumulative impacts.

The Corps also may not properly limit the application of a lower flood frequency elevation to assess wetland and other impacts without also applying that lower flood frequency elevation to assess project need and project benefits. Notably, if the flood frequency elevations are in fact lower now than they were in 2007, the areas at risk of flooding in the Yazoo Backwater Area would also be smaller now, which must be factored into the assessment of project need. If a smaller area in the Yazoo Backwater Area is now at risk of flooding without the Yazoo Pumps Alternatives, the areas that could potentially benefit from the Yazoo Pumps Alternatives will also be smaller—which means that the benefits will be smaller as well.

Notably, the DEIS also must explain why, in the face of these significant changes in flood elevation, the authorized level of flood protection (as set forth in the 1941 project authorization) has not already been achieved. Additional information on this important issue is provided in Section S of these comments.

2. The DEIS Improperly Limits the Spatial Extent of Its Wetland Impacts Analysis

While the DEIS has properly expanded its assessment of wetland impacts to include the 5-year floodplain, it is still artificially constraining the spatial extent of its wetland impacts analysis. The DEIS may not limit its analysis of wetland impacts in this way, instead it must analyze wetland impacts **wherever** those impacts occur—whether above or below the 5-year floodplain elevation.[93]

[89] 88 Fed. Reg. at 43103.
[90] 2007 EIS, Appendix 6 at page 6-44.
[91] 88 Fed. Reg. at 43103.
[92] 2007 EIS, 2007 FSEIS, Appendix 6 at page 6-44.
[93] In the Notice of Intent for this DEIS, the Corps noted that "there are fewer wetlands anticipated to be impacted between the 90.0-93.0 ft elevations than between the 89.3-92.0 ft elevations, which translates to fewer wetlands to assess for impacts and likely less compensatory mitigation needs." 88 Fed. Reg. at 43103. Despite the confusing nature of this statement (because the area where the Corps anticipates fewer impacts includes much of the same area whether the Corps expects greater impacts), it suggests an intent to inappropriately restrict the lower bounds of the Corps' wetland impact assessment. It is not clear from the DEIS whether this happened.

Analyzing the full extent of wetland impacts is required to properly identify the least environmentally damaging alternative, as required by the Clean Water Act 404(b)(1) Guidelines; and for properly avoiding, minimizing, and mitigating for wetland, stream, and fish and wildlife impacts as required by the Clean Water Act and 33 USC § 2283.

Importantly, analyzing the full extent of wetland impacts—whether above or below the 5-year floodplain elevation is explicitly supported by the Corps' Corps' own HGM Guidebooks.[94,95] For example:

(1) The July 2013 Regional Guidebook makes clear that <u>any</u> category of wetlands can, and do, occur above the 5-year return interval and that reliance on the 5-year return interval as the demarcation line for the riverine wetland subclass is just a rule of thumb. For example, as highlighted below the guidebook makes it clear that "all connected wetlands are assumed to be fully functional" where the frequency of flooding variable is used.[96] The guidebook also makes it clear that part of the reason the Corps' selected the 5-year return interval had nothing to do with wetland functions:

> This [5-year] return interval is regarded as sufficient to support major functions that involve periodic connection to stream systems. It was also selected as a practical consideration, because the hydrologic models used to develop flood return interval maps generally include the 5-year return interval.[97]

(2) The July 2013 Regional Guidebook makes clear that "all connected wetlands are assumed to be fully functional" where the frequency of flooding variable is used.[98] As discussed in Section G.2 of these comments, the many hydrological connections and mechanisms by which streams and wetlands, singly or in aggregate, affect the physical, chemical, and biological integrity of downstream waters are documented in the EPA report entitled *Connectivity of Streams and Wetlands to Downstream Waters: A Review and Synthesis of the Scientific Evidence*.[99]

For example, as recognized in the July 2013 Regional Guidebook HGM regional guidebook, many of the region's wetlands are connected through the shallow alluvial aquifer.[100] This aquifer "is a significant component of the hydrology of the [Mississippi Alluvial Valley]" that is "recharged by surface water."[101] "Generally, the surface of the alluvial aquifer is within 10 m of the land surface"[102] and it "is essentially continuous thorough the Mississippi Alluvial Valley."[103] According to the guidebook, both subclasses of "flat" wetlands, which are the classification of

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[94] 2013 HGM Regional Guidebook at 27.
[95] Brinson, M.M., et al. 1995. A Guidebook for Application of Hydrogeomorphic Assessments to Riverine Wetlands. Wetlands Research Program Technical Report WRP-DE-11 at 1-5.
[96] 2013 HGM Regional Guidebook at 61.
[97] 2013 HGM Regional Guidebook at 27.
[98] 2013 HGM Regional Guidebook at 61.
[99] EPA, Connectivity of Streams and Wetlands To Downstream Waters: A Review and Synthesis of the Scientific Evidence (Final Report, 2015), *available* at https://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=296414.
[100] 2013 HGM Regional Guidebook at 14-15.
[101] Id.
[102] Id.
[103] Id.

wetlands that are principally sustained via precipitation with little to no surface or subsurface connections, "are not common in the [Mississippi Alluvial Valley]."[104]

A 2008 independent hydrologic study also highlights this connectivity, highlighting that wetlands "across the Yazoo River basin [are] characterized by extremely flat topographic surface water connections and mosaics of complex drainage patterns."[105] Critically, that study found that the Corps' failure to account for these critical connections caused the Corps to understate the impacts of the 14,000 cfs pumps recommended by the Corps in 2007 by a massive 37,000 acres. Accounting for those connections showed that the pumps would drain "37,000 acres of jurisdictional wetlands in addition to the 26,300 acres reported by the USACE."[106]

(3) The 2013 HGM Regional Guidebook makes clear that riverine wetlands that have been degraded due to flow alterations caused by flood control and drainage projects must still be classified as "riverine wetlands" (and assessed), even if they fall outside the area with a 20-percent annual chance of flooding,[107] as discussed above.

(4) The 1995 HGM Riverine Guidebook does not rely on a specific flood-return interval for classifying a riverine wetland but instead evaluates the geomorphic setting and water sources to determine the appropriate wetland class. This guidebook states that riverine wetlands are "a class of wetlands that has a floodplain or riparian geomorphic setting" and are sustained by a ratio of more than 33-percent surface flow more than 33-percent groundwater, and less than 33-percent precipitation. The guidance highlights that this ratio is not distinct, but is instead a gradient, and that gradients between wetland classes are "continuous".[108]

Critically, the Corps' reliance on the post-1978 period of record to establish the new flood frequency elevations highlighted above, also translates into an inappropriate reduction in the spatial extent of the Corps' wetland impact assessment. If these changes are accurate (and our organizations note that the Corps has provided any evidence to support these "new" elevations), they indicate that flooding is occurring less frequently than it did in the past—i.e., less frequently than it did under the period of record used for the 2007 EIS—and that the area within the 5-year floodplain (20-percent ACE) is also smaller than it was in the past. If the Corps follows its typical, incorrect practice of only considering riverine wetland impacts within the 5-year floodplain, the "new" elevations also would translate into the Corps looking at a much smaller area for assessing riverine wetland impacts.

"According to the Corps, the Yazoo Backwater Area contains between 150,000 to 229,000 acres of wetlands."[109] Since, as acknowledged in the Corps' 2013 HGM Regional Guidebook, most of these wetlands are connected via surface or subsurface flow, draining water from the lower elevations will inevitably impact wetlands at higher elevations as gravity pulls water down from the higher to the lower elevations. This will inevitably cause connected wetlands at higher elevations to change due to the new

[104] Id at 30-31.
[105] Nutter Technical Memorandum No. 07-059.01 .
[106] Id. at 3, 12.
[107] 2013 HGM Regional Guidebook at 7.
[108] Brinson, M.M., et al. 1995. A Guidebook for Application of Hydrogeomorphic Assessments to Riverine Wetlands. Wetlands Research Program Technical Report WRP-DE-11 at 1-5.
[109] 2008 Clean Water Act Section 404(c) Final Determination at i.

flow regimes. Those wetlands must be categorized, and their impacts must be assessed and included in the cost of mitigation.

3. The DEIS Does Not Properly Account for Lost Wetland Functions

In addition to accurately assessing the spatial extent of wetland and stream impacts, the DEIS must accurately assess the loss or modification of wetland functions and the ecological implications of those changes. This is particularly critical for the DEIS, as the Yazoo Pumps are specifically designed to reduce, eliminate, and otherwise modify overbank flooding.

The DEIS does not properly account for lost wetland functions, including by relying on approaches explicitly rejected in the Clean Water Act veto. For example:

(a) The DEIS sums the HGM assessments of eight functional capacity units[110] that will be affected by the Yazoo Pumps Alternatives to determine the amount of functions capacity units that would be lost per habitat unit due to the Yazoo Pumps Alternatives and for determining the amount of functions capacity units that would be gained per habitat unit through mitigation.[111] However, this approach was explicitly rejected in the 2008 Clean Water Act veto because it can obscure significant losses of individual functions and suggest that mitigation can be achieved by offsetting one function with another **different** function.[112]

(b) The DEIS HGM assessment assumes that vegetative composition in the Yazoo Backwater Area wetlands will remain essentially static overtime,[113] even though slight changes in wetland hydrology can cause "massive changes in [plant and animal] species composition and richness and in ecosystem productivity."[114] However, this approach was rejected by EPA as invalid in the Clean Water Act veto.[115]

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[110] These functional capacity units are the same as those evaluated in the 2008 Clean Water Act veto: detain floodwater, detain precipitation, cycle nutrients, export organic carbon, physical removal of elements and compounds, biological removal of elements and compounds, maintain plant communities, and provide wildlife habitat.

[111] DEIS, Appendix F-5 Wetlands at 88-132.

[112] 2008 Clean Water Act veto, Appendix 6 Underestimation of Project Impacts and Overestimation of Project Benefits in the FSEIS for the Yazoo Backwater Area Project at 1-4.

[113] See Maintain Plant Community Values in Multiple Tables. DEIS, Appendix F-5 Wetlands at 88-124.

[114] William J. Mitsch and James G. Gosselink, *Wetlands* (5th ed.) (2015) at 112.

[115] 2008 Clean Water Act veto, Appendix 6 Underestimation of Project Impacts and Overestimation of Project Benefits in the FSEIS for the Yazoo Backwater Area Project at 1-2 ("Despite the pumping project, the HGM assessment assumes that vegetative species composition remains approximately static over time. Over the course of the 50-year project and beyond, the vegetation structure of the Yazoo Backwater Area would change as significant areas at higher elevations shift to drier species composition. The FSEIS's HGM assessment assumes that vegetative species composition remains static through time or that the species shift would still be within the range of reference standards. However, if the hydrologic regime of the area is significantly changed, as proposed, there would be much larger changes in the plant and animal community than was accounted for in the FSEIS's HGM assessment. The HGM Guidebook recognizes variation in vegetative community with varied hydrologic regimes and documents those changes with reference data (i.e., riverine backwater subclass, flats subclass, connected depression, isolated depression, etc.). It is reasonable to expect if hydrologic regimes are changed from riverine backwater to flats, then a vegetative change will occur as well.").

It is critical that the DEIS comprehensively examine the ecological implications of the impacts of the Yazoo Pumps Alternatives, including by far more carefully assessing the ecological impacts resulting from such things as:

- Eliminating, reducing, or otherwise modifying overbank flooding at the times, depths, and durations needed to sustain healthy populations of fish and wildlife.

- Undermining flood storage capacity by reducing the ability of the area's wooded wetlands to store floodwaters, reduce flood peaks, modify peak travel time.[116]

- Undermining nutrient and sediment removal capabilities since "reconnection of bottomland hardwood wetlands to their surrounding watershed through the restoration of surface hydrology is necessary to restore wetland functions important to nutrient and sediment removal."[117]

- Causing potentially "massive changes in species composition and richness and in ecosystem productivity."[118]

- Further depleting the already significant low stream flows in the Yazoo Backwater Area and the significantly depleted groundwater in the Mississippi Delta by impacting large swaths of wetlands that contribute to the protection and restoration of stream flow and groundwater recharge.

4. The DEIS Does Not Assess Impacts to Wetland Plants

Despite acknowledging the importance of wetland plant species, the DEIS does not assess the impacts of the Yazoo Pumps Alternatives on wetland plant species and plant species composition. The DEIS also does not assess the cascading impact to fish and wildlife from these flora changes. The DEIS does not assess impacts to wetland plants. Instead, the DEIS improperly assumes that wetland plant communities will remain relatively static despite the significant impacts of the Yazoo Pumps Alternatives, as discussed above.

The failure to assess impacts to wetland plants and plant communities is a fundamental flaw in the DEIS given the essential role that those plant communities have in supporting and maintaining fish and wildlife and other critical wetland functions. The failure to assess plant impacts is also unacceptable because as it is well recognized that even slight changes in wetland hydrology—which will unquestionably occur as a result of the Yazoo Pumps Alternatives—can cause "massive changes in [plant and animal] species composition and richness and in ecosystem productivity."[119]

While it is critical to assess the impacts of the Yazoo Pumps Alternatives on the federally endangered pondberry—and the DEIS claims will happen—the DEIS may not limit its analysis of impacts to plants to

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[116] Acreman, M., Holden, J. 2013. How wetlands affect floods. Wetlands, 33 (5). 773-786. 10.1007/s13157-013-0473-2.
[117] Hunter, R.G., Faulkner, S.P. & Gibson, K.A. The importance of hydrology in restoration of bottomland hardwood wetland functions. Wetlands 28, 605–615 (2008). https://doi.org/10.1672/07-139.1.
[118] William J. Mitsch and James G. Gosselink, *Wetlands* (5th ed.) (2015) at 112.
[119] William J. Mitsch and James G. Gosselink, *Wetlands* (5th ed.) (2015) at 112.

this single species. See Section I of these comments for a discussion of the evaluations needed to assess impacts to the federally endangered pondberry.

5. The DEIS Does Not Assess Impacts to Permanently Protected Wetlands

The DEIS does not assess the impacts of the Yazoo Pumps Alternatives on the many acres of wetlands that are supposed to be permanently protected in the Yazoo Backwater Area. These include wetlands in: the Delta National Forest, multiple National Wildlife Refuges complexes, lands enrolled in the USDA Wetland Reserve Easement Program, mitigation lands for other federal civil works projects, and state-protected lands. It is essential to assess and document impacts to these vital, protected areas to understand the full scope of the damage that would be caused by the Yazoo Pumps Alternatives.

6. The DEIS Does Not Assess Impacts to Wetlands from an Appropriate Range of Possible Operating Plans

The DEIS does not assess impacts to wetlands under an appropriate range of possible operating plans.

The DEIS does not provide a draft operating plan for the public to review, but what is clear from the DEIS is that even small changes in the operating regime can translate into significant additional wetland damage. For example, Alternative 2 includes 9 extra days of pumping below the 90-foot elevation as compared to Alternative 3. But these 9 extra days result in **an additional 3,467 acres** of wetland damage. The Corps added these 9 extra days of pumping in response to comments made during the scoping period public hearings. And the Corps is both considering—and is being asked to—make additional changes to the operating plan to operate the pumps for longer periods of time at and at lower elevations. See Section A of these comments.

Even if the Corps does not adopt such changes now, operating plans can—and typically do—change over time. Indeed, the Corps' regulations require the Corps to "keep approved water control plans up to date" including by subjecting those plans "to continuing and progressive study by personnel in field offices of the Corps of Engineers."[120] See Section A of these comments. In addition, the pressure to use the pumps more often and at lower elevations will undoubtedly intensify once the pumps are built.

Given all of these factors, the proposed operating plans are not a reliable backstop for managing environmental harm (or for ensuring that the final selected plan is the least environmentally damaging practicable alternative). As a result, it is critical that the public and decision makers be made aware of the significant impacts that would accrue from the proposed 25,000 cfs pumping plant under a wide range of operating plans. Without this information it is not possible to assess the full array of potential risks associated with building the proposed, massive 25,000 cfs Yazoo Pumps.

[120] 33 CFR 225(f)(2).

D. The DEIS Does Not Assess Impacts to Streams

The DEIS does not assess impacts to the rich array of rivers, streams, and bayous within the Yazoo Backwater Area.[121]

As discussed throughout these comments, the Yazoo Pumps Alternatives will adversely impact 89,839 to more than 93,306 acres of ecologically significant wetlands in the Yazoo Backwater Area. These wetland losses will affect the Yazoo Backwater Area streams. Intensifying agricultural production in the Yazoo Backwater Area, which is the fundamental purpose of the Yazoo Pumps (and when last assessed, accounted for more than 80% of project benefits) also will lead to through increased cultivation, additional fertilizer and pesticide use, and potential land clearing. These impacts also will unquestionably affect the Yazoo Backwater Area's streams.

A state-of-the-art scientific review developed by EPA documents the hydrological connections and mechanisms by which streams and wetlands, singly or in aggregate, affect the physical, chemical, and biological integrity of downstream waters. The report, titled "Connectivity of Streams and Wetlands to Downstream Waters: A Review and Synthesis of the Scientific Evidence,"[122] makes five major conclusions summarized below:

(1) The scientific literature unequivocally demonstrates that streams, regardless of their size or frequency of flow, are connected to downstream waters and strongly influence their function.

(2) The scientific literature clearly shows that wetlands and open waters in riparian areas (transitional areas between terrestrial and aquatic ecosystems) and floodplains are physically, chemically, and biologically integrated with rivers via functions that improve downstream water quality. These systems act as effective buffers to protect downstream waters from pollution and are essential components of river food webs.

(3) There is ample evidence that many wetlands and open waters located outside of riparian areas and floodplains, even when lacking surface water connections, provide physical, chemical, and biological functions that could affect the integrity of downstream waters. Some potential benefits of these wetlands are due to their isolation rather than their connectivity. Evaluations of the connectivity and effects of individual wetlands or groups of wetlands are possible through case-by-case analysis.

(4) Variations in the degree of connectivity are determined by the physical, chemical and biological environment, and by human activities. These variations support a range of stream and wetland functions that affect the integrity and sustainability of downstream waters.

(5) The literature strongly supports the conclusion that the incremental contributions of individual streams and wetlands are cumulative across entire watersheds, and their effects on downstream waters should be evaluated within the context of other streams and wetlands in that watershed.

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[121] Impacts to these vital waters have never been assessed by the Corps.

[122] EPA, Connectivity of Streams and Wetlands To Downstream Waters: A Review and Synthesis of the Scientific Evidence (Final Report, 2015) (*available* at https://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=296414).

Given these hydrological connections and mechanisms, the DSEIS must analyze and mitigate the impacts of the Yazoo Pumps Alternatives on the rivers, streams, and bayous in the Yazoo Backwater Area, including such things as: (1) changes in water temperature; (2) changes in flow; (3) changes to the form and function of stream and river channels, which are typically driven by changes in flow patterns, reductions in flow, reduction or loss of natural flood-pulse, and loss of overbank flooding; (4) changes to in-stream and floodplain habitats; (5) further reductions in groundwater resulting from loss of wetland functions and additional irrigation to support intensified agricultural production); and (6) changes to water quality, including increased sedimentation, nutrient pollution, toxic contamination, and lower levels of dissolved oxygen. See Section J of these comments for more information on required assessments of water quality impacts.

Impacts to stream resources must be separately evaluated and mitigated, as a matter of law. The DEIS cannot simply ignore the impacts to the project area's vast array of streams.

E. The DEIS Dramatically Understates Impacts to the Hundreds of Fish and Wildlife Species that Rely on the Yazoo Backwater Area's Wetlands

The DEIS dramatically understates impacts to the hundreds of species of fish and wildlife that rely on the Yazoo Backwater Area's vital wetlands. The actual impacts from the Yazoo Pumps Alternatives will be much greater than acknowledged in the DEIS, including because the DEIS fails to carry out any assessment at all of extensive array of impacts to fish and wildlife. This is an egregious failing given the importance of the Yazoo Backwater Area's ecologically rich wetlands to more than 450 species of birds, fish, and wildlife. Located in the heart of the Mississippi River flyway, the Yazoo Backwater Area is especially important to migratory species, many of which are already experiencing alarming population declines.[123] Sixty percent of all North American bird species and 40% of North America's waterfowl migrate through the Mississippi River flyway.

For example:

- As documented by the National Audubon Society,[2] the Yazoo Backwater Area is used by 29 million migrating birds each year. More than 18 million birds migrate through the area each year during fall migration, and more than 10 million birds migrate through the area each year during spring migration. More than 6.3 million birds from 17 different overwintering species use the Yazoo Backwater Area from December through February.

- The Yazoo Backwater Area supports a highly productive floodplain fishery that includes at least 95 different species, if not more.[124] Of these, the U.S. Fish and Wildlife Service estimates that over 58 species depend on backwater flooding and access to the floodplain to fulfill numerous life history requirements.[125]

- The Yazoo Backwater Area is home to a number of at-risk species and species of special concern, including species designated as threatened or endangered under the Federal Endangered Species Act.

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[123] Kenneth V. Rosenberg, et al, Decline of the North American avifauna, Science, Vol. 366, No. 6461, pp. 120–124.
[124] Clean Water Act 404(c) Final Determination at 34.
[125] Id. (emphasis added).

EPA issued the 2008 Clean Water Act veto because the Yazoo Pumps "would result in unacceptable adverse effects on fishery areas and wildlife," highlighting the loss of spring flood pulses as of particular concern as those coincide with and support key lifecycles of fish and wildlife. Indeed, the veto "is based solely on environmental harms to fisheries and wildlife in the Yazoo Backwater Area" as "is appropriate given the structure and language of the CWA and case law."[126] In the veto, EPA also noted that the U.S. Fish and Wildlife Service "concurred with EPA's conclusion that the Yazoo Backwater Area Project would result in significant degradation and unacceptable adverse effects on wildlife and fisheries resources" and expressed appreciation for the veto acknowledging "the full breadth of the proposed project's anticipated adverse impacts to its four National Wildlife Refuges located within the project area."[127]

Accordingly, it is critical that the DEIS comprehensively examine and document the direct, indirect, and cumulative impacts of the Yazoo Pumps Alternatives and other alternatives on the full array of species that rely on the Yazoo Backwater Area, including fish, waterfowl, birds, mammals, reptiles, amphibians, and mussels. Close attention must be paid to at-risk species, including species listed under the Endangered Species Act and candidate species thereof, and species included in the Mississippi State Wildlife Action Plan.[128] The EIS also must comply with the consultation and other requirements of the Endangered Species Act and the requirements of the Fish and Wildlife Coordination Act.

To properly assess impacts to fish and wildlife, the Corps must use transparent and scientifically justified approaches. Critically, the Corps must first comprehensively evaluate the impacts of the project on the wetlands, streams, and conservation lands in the Yazoo Backwater Area. This evaluation must carefully account for the extent, timing, and duration of overbank flooding and resulting changes to water quality and quantity. Once baseline habitat losses and their ecological implications are determined, the implications of those changes must be assessed for the wildlife species that rely on the affected habitats. The Corps also must examine and document the impacts to fish and other aquatic species resulting from becoming entrained in the proposed 25,000 cfs pumps and/or from becoming stranded in the floodplain because of operation of the Yazoo Pumps Alternatives.

The DEIS also should, but does not, take advantage of the expertise of the U.S. Fish and Wildlife Service. Instead, the Corps opted to release the DEIS without having had the benefit of evaluating and considering the Services' views as expressed in the legally required Fish and Wildlife Coordination Act Report. Because the Fish and Wildlife Coordination Act Report is not included in the DEIS, the public also does not have the benefit of the Service's input to assist the public's evaluation of the DEIS's assessment of fish and wildlife impacts.

The assessment of habitat losses must include a careful evaluation of those changes that are significant for fish and wildlife, including wetland losses, loss or modification of wetland functions, and loss of natural flood pulses in the Yazoo Backwater Area. For example:

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[126] Clean Water Act 404(c) Final Determination at 70.

[127] Clean Water Act 404(c) Final Determination at 20. The Department of the Interior had previously concluded that the Yazoo Pumps "will have unacceptable adverse effects on fishery areas, including spawning and breeding areas" and "unacceptable adverse effects on wildlife, specifically to the area's breeding and migratory birds, including landbirds, shorebirds, wading birds, and waterfowl." U.S. Department of the Interior Comments on the 2007 FSEIS at 7, 9.

[128] Mississippi Museum of Natural Science. 2015. Mississippi State Wildlife Action Plan. Mississippi Department of Wildlife, Fisheries, and Parks, Mississippi Museum of Natural Science, Jackson, Mississippi (available at https://www.mdwfp.com/media/251788/mississippi_swap_revised_16_september_2016__reduced_.pdf).

> Disruption of lateral connectivity and the flood pulse can affect both aquatic and non-aquatic organisms, as well as nutrient processing, and other floodplain functions (Cobb et al. 1993, Lytle and Poff 2006 and references therein). For example, productivity of songbirds and waterfowl can be affected because of the influence of the flood pulse on predators and food availability (Heitmeyer 2006, Hoover 2006, Cooper et al. 2009, Hoover 2009). Furthermore, channelization and dams can alter the timing, depth, duration, and frequency of floods and disrupt synchronized linkages between the flood pulse and life history processes of organisms (Richter et al. 1997, Bunn and Arthington 2002, Heitmeyer 2006, Hupp et al. 2009).
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> Floodplain forests historically provided a variety of habitats for breeding amphibians, secretive marsh birds, and wintering and breeding waterfowl. Furthermore, the diversity of hydroperiods resulted in abundant aquatic invertebrate populations and high seed production by moist-soil plants. These food and structural resources are critical for fulfilling wintering, breeding, and migrating waterfowl and shorebird needs; however, they have been lost over broad expanses of the landscape as a result of widespread drainage. Such resources are not restored through simple planting of trees.[129]

The 2008 Clean Water Act veto (including its Technical Appendices) provided detailed information on the many species that rely on the Yazoo Backwater Area, discussed vital habitat needs for those species, and highlighted the harm that the Yazoo Pumps would cause to those species. These documents should form the foundation of the assessment of fish and wildlife impacts in the EIS.

The overwhelming majority of wildlife species in the South Delta are well-adapted to living and thriving in floodplain environments and rely on wetlands sustained by flooding for critical phases of their life cycles (including ducks, migratory songbirds, wading birds, raptors, snakes, frogs, salamanders, alligators to name a few). The tens of thousands of acres of damage to these vital wetlands that would be caused by the Yazoo Pumps Alternatives—and the elimination of spawning habitat caused by loss or reduction of overbank flooding—cannot be offset by rare large-scale flood events.[130]

The impacts to fish and wildlife must be assessed in light of an understanding of current population levels, existing stressors, and full life cycle needs of the species that utilize the project area. Lifecycle needs include such things as: fish spawning (including the timing, amount, and depth of overbank

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[129] Sammy L. King, et, al, The Ecology, Restoration, And Management of Southeastern Floodplain Ecosystems: A Synthesis, Wetlands, Vol. 29, No. 2, June 2009, pp. 624–634.

[130] Moreover, even during the prolonged 2019 floods, many factors unrelated to flooding played a role in wildlife impacts. For example, while significant numbers of White-tailed deer perished in 2019, a large number of those deer were deliberately culled—645 deer were killed in the Yazoo Backwater Area counties during the 2019 flood under depredation permits issued by the Mississippi Department of Wildlife, Fisheries, and Parks. Many deer in the Yazoo Backwater Area also had the ability to flee to higher ground but did not, according to William McKinley, Mississippi's deer program coordinator. Many factors likely aggravated the impacts of the 2019 flood on the White-tailed deer in the Yazoo Backwater Area, including the extensive flood-control works and widespread conversion of habitat to agriculture that eliminated vital habitat, reduced the resiliency of the deer population, and created artificial barriers to wildlife movement. The Resilience Alternative proposed in these comments would protect and restore contiguous habitat corridors that could be used by deer to migrate out of the area during large-scale floods.

flooding needed to trigger spawning), fish rearing, fish refugia; breeding, rearing, resting, and feeding for all species; and for migratory species the availability of food and stopover habitat throughout their migratory cycles. The Corps must fully assess and account for impacts that prevent fish and wildlife from accessing the right habitats and food supplies at the times of the year (and for the right amount of time) needed to support these critical lifecycle needs. To do this, the Corps must ensure that it is not masking or understating the adverse impacts of the Yazoo Pumps Alternatives, including by relying on such things as annual, seasonal, and monthly averages of impacts to assess habitat losses, or failing to assess impacts to species with different or more specialized habitat and food source needs.

A careful and robust assessment of these needs is critically important for understanding the true extent of adverse impacts to fish and wildlife because the Yazoo Pumps Alternatives will keep water levels at extremely low elevations **during the time periods that are most critical for migration, breeding, spawning, and rearing** to benefit industrial-scale agriculture:

- Alternative 2 would damage at least **93,306 acres of wetlands** by keeping water levels at or below the 90-foot elevation—the 2-year floodplain—throughout the migration, breeding, spawning and rearing breeding periods. Alternative 2 would keep water levels at or below the 90-foot elevation from March 16 through October 15 (214 days or 7 months)

- Alternative 3 would damage at least **89,839 acres of wetlands** by keeping water levels at or below the 90-foot elevation—the 2-year floodplain—throughout the migration, breeding, spawning, and rearing periods. Alternative 3 would keep water levels at or below the 90-foot elevation from March 25 through October 15 (205 days or 6 months and 21 days).

Critical problems with the DEIS assessment of fish and wildlife impacts are discussed below.

F. The DEIS Significantly Understates Impacts to Native Birds

The DEIS significantly understates the adverse impacts of the Yazoo Pumps Alternatives on the rich array of bird species that rely on the Yazoo Backwater Area (and as a result, the mitigation that would be required to attempt to offset those impacts). For example, the DEIS fails to assess impacts on native bird species during critical life-cycle periods—which unquestionably results in the DEIS significantly understating impacts. The limited assessments that have been carried out are plagued by substantially flawed assumptions and a fundamental lack of transparency that render these models questionable at best, and incorrect at worst. The failure to assess the full array of impacts to native birds is an egregious error, given the hemispheric significance of the Yazoo Backwater Area to bird species.

As discussed above, the Yazoo Backwater Area's hemispherically significant wetlands are located in the heart of the Mississippi River Flyway—a major continental migration corridor—and support 257 bird species, including several species recognized as state and/or federally threatened or endangered, or as a Species of Greatest Conservation Need.[131,132] Approximately 60% of all North American bird species depend upon the Mississippi River basin's habitats, including 40% of all waterfowl and shorebirds that migrate along the Mississippi River Flyway.

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[131] 2008 Clean Water Act veto, Appendix 2 "Yazoo Backwater Area Faunal Species Lists".
[132] Species of Greatest Conservation Need (SGCN) are aquatic or terrestrial animals that have been recognized by the State of Mississippi as at risk or in decline, and as such are identified in the 2015 State Wildlife Action Plan as the species most in need of conservation action.

The value of the Yazoo Backwater Area is further demonstrated by the myriad of state and/or federally managed refuge, forest, and wildlife management areas located in the Yazoo Backwater Area that have been recognized as by BirdLife International and the National Audubon Society as Important Bird Areas (IBAs) for resident and migratory birds and waterfowl. These include Delta National Forest, Panther Swamp and Yazoo National Wildlife Refuges, and Mahannah Wildlife Management Area, as well as Eagle Lake in Warren County.[133] In addition, the Lower Mississippi Valley Joint Venture has identified additional wetland areas within the Yazoo Backwater Area that should be protected and restored to sustain bird populations.[134,135]

For the most abundant 180 species that rely on the Yazoo Backwater Area, approximately **29 million birds use the region**, as documented by an eBird abundance analysis prepared by the National Audubon Society[136]:

- More than 18 million birds migrate through the Yazoo Backwater Area each year during fall migration, including approximately 6.6 million shorebirds.[137]
- More than 10 million birds migrate through the Yazoo Backwater Area each year during spring migration, including 2.8 million shorebirds.[138]
- More than 6.3 million birds from 17 different species overwinter in the Yazoo Backwater Area during the overwintering period from December through February.[139]

Each of these 180 species of birds also utilize (migrate and/or breed) in the region during the Alternative 2 and Alternative 3 crop seasons, when the 25,000 cfs pumps will drain water below the 2-year floodplain elevation (90-feet NGVD). As a result, the proposed Yazoo Pumps Alternatives will drain water to exceptionally low levels—levels explicitly prohibited by the 2008 Clean Water Act veto—precisely when that water is needed the most by migratory and breeding birds. Water levels will also be kept at artificially low levels when the water is needed the most by overwintering birds.

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[133] An Important Bird Area (IBA) is an area that has been identified using an internationally agreed to set of criteria as being globally important for the conservation of bird populations. National Audubon Society administers this program in the United States. Source: National Audubon Society website at https://www.audubon.org/important-bird-areas/state/mississippi (last visited August 20, 2024).

[134] Lower Mississippi Valley Joint Venture. 2015. MAV Waterfowl Stepdown State Summaries. LMVJV Waterfowl Working Group c/o Lower Mississippi Valley Joint Venture, Vicksburg, MS. https://www.lmvjv.org/s/MAV_Waterfowl_Stepdown_FINAL_12-2-15_MSsummary.pdf.

[135] Edwards, T., D. Fuqua, D. James, T. Kreher, P. Link, L. Naylor, F. Nelson, E. Penny, G. Pogue, St. Reagan, K. Reinecke, J. Tirpak. 2012. Allocation of Waterfowl Habitat Objectives within the Mississippi Alluvial Valley: An Analytical Framework and Results. Lower Mississippi Valley Joint Venture Waterfowl Working Group. https://www.lmvjv.org/s/WWGTS_AllocationReport_Approved_6-5-12_12415-s856.pdf

[136] Approximately 9.1 million landbirds and approximately 9.6 million waterbirds use the Yazoo Backwater Area during fall migration. Approximately 5.9 million landbirds and approximately 4.3 million waterbirds use the Yazoo Backwater Area during the spring migration. Audubon eBird Abundance Analysis at Attachment E.

[137] Id. The Clean Water Act veto acknowledged that at least 500,000 to 1,000,000 shorebirds migrate through this area on a biannual basis. Clean Water Act Veto Final Determination at 26.

[138] Audubon eBird Abundance Analysis.

[139] Id.

The chart below highlights 35 water-dependent bird species whose populations are exceptionally reliant on the Yazoo Backwater Area (Figure 1). **At least 1% of the continental population of each of these species utilize the Yazoo Backwater region in spring, fall, or both seasons. Among these, 15 species are considered "conservation priority" by one or more state, regional, or continental conservation plans**.

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Wetland Dependent Bird Species with >1% of Continental Populations Dependent on the Yazoo Backwater Area					
Species	% Pop. Spring	% Pop. Fall	PIF State of the Birds[3]	USFWS Birds of Conservation Concern[140]	MS State Wildlife Action Plan[141]
Greater White-fronted Goose	**<1%**	**25-50%**			
Blue-winged Teal	**10-25%**	**10-25%**			
Northern Shoveler	5-10%	<1%			
Green-winged Teal	5-10%	<1%			
Canvasback	1-5%	<1%			
Lesser Scaup	1-5%	<1%			S5N
Ruddy Duck	1-5%	<1%			
Pied-billed Grebe	1-5%	1-5%			
American Coot	<1%	1-5%			
Black-necked Stilt	<1%	5-10%			
American Avocet	<1%	1-5%			
American Golden-Plover	**25-50%**	**<1%**	**Tipping Point**	**Continental**	
Semipalmated Plover	1-5%	1-5%			
Stilt Sandpiper	**10-25%**	**25-50%**	**Tipping Point**		
Dunlin	1-5%	<1%			S4N
Least Sandpiper	**10-25%**	**>50%**			
White-rumped Sandpiper	**10-25%**	**<1%**			
Pectoral Sandpiper	**>50%**	**>50%**	**Tipping Point**	**Continental**	
Semipalmated Sandpiper	**5-10%**	**10-25%**	**Tipping Point**	**Regional**	
Western Sandpiper	<1%	5-10%			S4N
Short-billed Dowitcher	1-5%	5-10%	Tipping Point		
Long-billed Dowitcher	**1-5%**	**>50%**	**On Alert**		
Wilson's Snipe	<1%	1-5%			
Spotted Sandpiper	<1%	1-5%			
Solitary Sandpiper	1-5%	1-5%			
Lesser Yellowlegs	**25-50%**	**10-25%**	**Tipping Point**	**Continental**	
Greater Yellowlegs	5-10%	<1%			
Interior Least Tern	<1%	1-5%		Continental	S2B
Double-crested Cormorant	1-5%	1-5%			
Great Blue Heron	<1%	1-5%			
Snowy Egret	**<1%**	**10-25%**			**SS4B, S1N**
Tricolored Heron	<1%	1-5%			S2B, S1N
Yellow-crowned Night-Heron	<1%	5-10%			S3B, S1N
Roseate Spoonbill	**<1%**	**25-50%**			
Prothonotary Warbler	1-5%	<1%		Continental	S5B

Figure 1. Wetland-dependent species and their conservation prioritization status for which at least 1% of the continental population is supported by the Yazoo Backwater Area region. Species with >10% of the continental population supported during either spring or fall are in bold font. Species are listed in taxonomic order.[142]

[140] 2021 U.S. Fish and Wildlife Service Birds of Conservation Concern (available at https://www.fws.gov/media/birds-conservation-concern-2021).

[141] 2015 Mississippi State Wildlife Action Plan (available at https://www.mdwfp.com/media/251788/mississippi_swap_revised_16_september_2016__reduced_.pdf).

[142] Chesser, R. T., S. M. Billerman, K. J. Burns, et. al,. 2022. Check-list of North American Birds (online). American Ornithological Society. (available at https://checklist.americanornithology.org/taxa/).

Audubon estimates that the **Yazoo Backwater Area supports more than 10% of the continental population for 12 species of birds during either spring or fall migration** (Figure 1). Five of those species are projected to lose more than 50% of their populations in the next 50 years without significant conservation action, referred to as "tipping point" species. One additional tipping point species, the Short-billed Dowitcher, also relies heavily on the Yazoo Backwater Area which is used by approximately 8% of the Short-billed Dowitcher's hemispheric population in fall migration. Six of these species have been identified by the 2022 Partners in Flight State of the Birds report[143] as "on alert" species, defined as species that have lost at least 50% of their populations from 1970-2019.

Each of these species has slightly different water requirements, such that variation in the amount (i.e., depth) and seasonal timing of water in the landscape is necessary to maintain existing population levels for all of these species. For example, long-legged wading birds (e.g., Snowy Egret and Roseate Spoonbill) prefer shallow standing water, often < 15 cm in depth[144,145], whereas small sandpipers prefer a thin sheet of water (i.e., < 4 cm in depth) or exposed mudflats[146,147], and waterfowl prefer deeper waters, such as around 30 cm for Blue-winged Teal[148,149]. The timing of these water needs also differs among taxa, especially in fall and winter, with long-legged wading birds dispersing into the region from large rookeries to the south between late June through August, migratory shorebirds between mid-July through October, and some waterfowl from as early as August (i.e., Blue-winged Teal), but primarily from October through March. These species have evolved the timing of their migrations to best match the natural climatic and hydrological processes in the Mississippi River watershed.

Bird migration requires a series of links of key regions and habitats, connecting the arctic in northern Canada to the southern tip of Argentina. Should any of these links be broken for the species that depend on them, the entire migration balance falls apart. Human modifications to those vital links have resulted in the loss of 2.5 billion migratory birds from the U.S. and Canada in just the last 50 years.[150] Alternatives 2 and 3 will amplify this dire problem, with negative population-level consequences for multiple species.

It is beyond dispute that the Yazoo Pumps would cause unacceptable harm to native birds, as unequivocally recognized in the 2008 Clean Water Act veto. For example, as documented in the veto:

[143] 2022 Partners in Flight State of the Birds Report (available at https://www.stateofthebirds.org/2022/taxonomic-list-of-on-alert-and-tipping-point-species/).
[144] Parsons, K. C. and T. L. Master (2020). Snowy Egret (*Egretta thula*), version 1.0. In Birds of the World (A. F. Poole and F. B. Gill, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.snoegr.01.
[145] Dumas, J. V. (2020). Roseate Spoonbill (*Platalea ajaja*), version 1.0. In Birds of the World (A. F. Poole and F. B. Gill, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.rosspo1.01.
[146] Brown, S., C. Hickey, B. Harrington, and R. Gill, eds. 2001. The U.S. Shorebird Conservation Plan, 2nd ed. Manomet Center for Conservation Sciences, Manomet, MA.
[147] LMVJV Shorebird Working Group. 2019. Lower Mississippi Valley Joint Venture Shorebird Plan. Lower Mississippi Valley Joint Venture Office, Jackson, MS, USA. https://www.lmvjv.org/shorebird-plan.
[148] Rohwer, F. C., W. P. Johnson, and E. R. Loos. 2020. Blue-winged Teal (*Spatula discors*), version 1.0. In Birds of the World (A. F. Poole and F. B. Gill, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.buwtea.01.
[149] North American Waterfowl Management Plan (NAWMP) Update: Connecting People, Waterfowl, and Wetlands. 2018. https://www.fws.gov/partner/north-american-waterfowl-management-plan.
[150] Rosenberg, K.V., Dokter, A.M., Blancher, P.J., Sauer, J.R., Smith, A.C., Smith, P.A., Stanton, J.C., Panjabi, A., Helft, L., Parr, M. and Marra, P.P., 2019. Decline of the North American avifauna. *Science*, *366*(6461), pp.120-124.

> The loss of the productive shallowly flooded wetlands, especially in the spring months when the proposed pumps will typically be in operation, will impact migratory birds such as shorebirds and waterfowl as they stopover and forage in preparation for their seasonal migration. Fewer shallowly flooded wetlands will reduce foraging habitat, which will equate to reduced nutritional uptake and could result in higher mortality or reduced reproductive fitness as the birds travel the great distances between their southern wintering areas and their breeding areas in the northern U.S., Canada, and the Arctic. Breeding for many species could be adversely affected during the spring-time nesting season because foraging areas would be reduced. As a result of the reduction in flooding, adult birds will have to travel longer distances to find food, which equates to longer times away from the nest or foraging for food and may ultimately lead to higher nest mortality and lower recruitment (Appendix 4).[151]
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> The proposed project would reduce the extent of flooding within wetlands in the 2- to 5-year floodplain potentially from January through June. The reductions to late winter and spring flooding would result in significant adverse impacts to those birds which not only utilize the Yazoo Basin, but are dependent upon backwater flooding during these periods…The reduction in the extent and duration of the spring flood pulse would accelerate the decline of many bird species that depend upon the wetland habitats of the lower Yazoo River (Appendix 4).[152]
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> . . .
>
> For many shorebird species, migration "stop-over" habitats play a vital role in their ability to accumulate fat reserves. Shorebirds unsuccessful in obtaining necessary fat are thought to have very low survival rates (Brown, Hickey, and Harrington, 2000). If these fat deposits are crucial for breeding and if they are dependent on feeding conditions on migratory stopovers south of breeding area, then changes in quantity and quality of migratory habitat could influence breeding populations and fitness parameters (Appendix 4).[153]

The Clean Water Act veto also makes clear that the project-induced damage to wetland plants will compound the adverse impacts to native birds from the loss of habitat. For example:

> Different wetland species require wet and dry conditions at different times in their life cycle. The various elevations of land in a floodplain combined with various hydrologic events create numerous habitat conditions which are available to animals and plants at different times. It was the spatial and temporal heterogeneity of these bottomland hardwood ecosystems which provided the components for the great biodiversity for which this region was once known (Schnitzler et al., 2005), vestiges of which remain today. The topographic and hydrologic complexity of floodplains is important to the distribution of plant communities, and it is these plant communities that create the primary production necessary to support the immensely diverse food web that make bottomland hardwood ecosystems unique.[154]

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[151] 2008 Clean Water Act veto at 57.
[152] 2008 Clean Water Act veto at 58.
[153] 2008 Clean Water Act veto at 40.
[154] 2008 Clean Water Act veto at 23.

. . .

Floristic composition and successional patterns are strongly influenced by the hydrologic events on the sites and particularly by rates and types of deposition. Small differences in elevation can result in great differences in site quality primarily because of differences in hydrology (Hodges, 1997).[155]

. . .

The ability of riverine backwater wetlands to maintain a characteristic plant community is important because of the intrinsic value of the plant community and the many attributes and processes of wetlands that are influenced by the plant community. For example, primary productivity, nutrient cycling, and the ability to provide a variety of habitats necessary to maintain local and regional diversity of animals are directly influenced by the plant community. Due to the inundation by nutrient rich surface water, diverse assemblages of plants grow in riverine backwater wetlands and contribute to the primary production of these ecosystems. The growth of different plant communities as a result of variable hydrologic regimes and topography contributes to the uptake and release of nutrients and provides many layers of potential habitat (i.e., litter layer to canopy) for the hundreds of wildlife species which utilize these wetlands. In addition, the plant community of river connected wetlands such as riverine backwater wetlands in the Yazoo River Basin influences the quality of the physical habitat, nutrient status, and biological diversity of downstream systems. As noted in the Yazoo Basin HGM Guidebook, maintaining the natural hydrologic regime of these wetlands is consistently cited as the principal factor controlling plant community attributes (Smith and Klimas 2002).[156]

. . .

Most wildlife and fish species found in riverine backwater wetlands of the Yazoo River Basin depend on certain aspects of wetland structure and dynamics such as specific vegetation composition and proximity to other habitats, but of particular importance to the life cycles of these species is the periodic flooding or ponding of water associated with the hydrologic regime of riverine backwater wetlands (Smith and Klimas 2002).[157]

. . .

In addition to the information provided in the FSEIS, EPA evaluated additional information regarding faunal assemblages and species in the project area, including information provided by the FWS at the request of EPA (Appendix 4). As noted above, the Yazoo Backwater Area is an area that is micro-topographically and geomorphologically diverse. It can be broadly classified as a river-floodplain ecosystem characterized by seasonal floods which exchange nutrients and organisms among a mosaic of habitat types. The movement of surface water onto the floodplain and the associated exchange of materials lead to the biological productivity of these bottomland hardwood ecosystems (Junk et al., 1989; Bunn and Arthington, 2002; and Sparks, 1995). A growing body of evidence indicates that the ecological diversity and integrity of large floodplain rivers are maintained by flood pulses, channel-forming floods, and by river-floodplain

[155] 2008 Clean Water Act veto at 23-24.
[156] 2008 Clean Water Act veto at 31.
[157] 2008 Clean Water Act veto at 32.

> connectivity. The native biota has developed strategies to take advantage of these flood pulses.[158]

The Clean Water Act veto also makes clear that the project-induced impacts to amphibians and reptiles will compound the adverse impacts to native bird species. For example:

> All of the 21 amphibian species, and all but 5 of the 37 reptile species benefit from the flood pulse. Shallow areas at the periphery of the flooded zone hold water for the shortest period, from days to a couple of months, and provide breeding habitat for species such as the mole salamanders, which are winter breeders in Mississippi, and for winter-breeding frogs such as leopard frogs, pickerel frogs, spring peepers, and chorus frogs. Areas which are deeper and flooded for longer periods (i.e., places closer to the main channel of the river) are utilized by the summer-breeding frog species as water levels drop in late spring and summer. Larval amphibians make significant contributions to the biomass of other vertebrates, including many of the wading birds. Aquatic turtles, such as the common red-ear slider, also support the diet of many species of fish, birds, and mammals, which eat their eggs and hatchling turtles. Turtles produce several clutches of eggs per season, over a reproductive lifetime of several decades, and thus can be a significant food source for numerous aquatic and terrestrial species (Appendix 4).[159]
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> . . .
>
> Fourteen of 18 species of wading birds found in North America use bottomland hardwood habitats, and 12 of these species breed regularly in this system (Heitmeyer et al., 2005). Diets of most wading birds vary with seasonal availability, and many species forage extensively on small fish, amphibians, reptiles, and crayfish. Waders generally depend on seasonally-fluctuating water levels in bottomland hardwood and associated wetlands to make prey more available. One species that nests in the Yazoo Backwater Area, the Little Blue Heron, has recently shown declines in its population. Although the overall causes for this population change cannot be directly determined, it is believed that altered hydrocycles and habitat conversion have caused and continue to cause the greatest threats to this species. Food limitation, caused by wetland destruction and degradation, appears to be a significant factor controlling its breeding success and, therefore, its population numbers (Rodgers and Smith, 1995). Among the wading birds listed as priority species for management in the LMRAV are the following: Little Blue Heron, Tricolored Heron, American Bittern, Least Bittern, Black-crowned Night Heron, Yellow-crowned Night Heron, Great Egret, White Ibis, and Wood Stork (Appendix 4).[160]

As discussed below, the DEIS significantly understates the impacts of Alternatives 2 and 3 on the native birds that rely on the Yazoo Backwater Area and, as a result the mitigation that would be required to attempt to offset those impacts.

[158] 2008 Clean Water Act veto at 32.
[159] 2008 Clean Water Act veto at 33.
[160] 2008 Clean Water Act veto at 40.

1. The DEIS Significantly Understates Impacts to Waterfowl (Appendix F-5)

The DEIS analysis of waterfowl impacts significantly underestimates the impact of Alternatives 2 and 3 on waterfowl. Among other problems, this analysis is based solely upon an assessment of lost duck use days (DUDs) during the overwintering period of November 1 through February 28.

According to the DEIS, this DUD assessment shows that the Yazoo Pumps Alternatives would result in the loss of 196,648 or 202,798 annual DUDs on average.[161] However, at best, this provides just a partial picture of the damage to waterfowl, including because:

(a) The DEIS does <u>**not**</u> **assess impacts to breeding waterfowl**, which include the Wood Duck and Hooded Merganser. DUDs typically are not used to assess impacts to breeding waterfowl, and the DEIS waterfowl assessment relied on a DUD manual that acknowledges that it does <u>not</u> provide energy needs for breeding waterfowl.[162] Other methods, however, are available for assessing impacts to breeding waterfowl.

(b) The DEIS does <u>**not**</u> **assess impacts to migrating waterfowl**, including for the economically important Blue-winged Teal, because it fails to consider or quantify impacts from mid-August through October, and again in March through mid-April.

(c) The DEIS does <u>**not**</u> **assess or account for multiple adverse impacts** to waterfowl, including highly significant cumulative impacts, and many of the impacts analyses that are carried out are fundamentally flawed.

(d) The DEIS **may <u>not</u> rely solely** on DUD model outputs to identify needed mitigation because the model can at best provide an estimate of relative loss, it does not provide a precise prediction of lost duck use days.

Because of these many failings, the mitigation that has been proposed to offset waterfowl impacts is not sufficient—even if the limited amount of mitigation proposed could somehow replace all lost functions and values critical to waterfowl, which it cannot.

(a) The DEIS Does Not Assess or Account for Impacts to Breeding Waterfowl

The DEIS does not assess or account for impacts to waterfowl during the critical breeding season. Instead, the DEIS bases its entire analysis of waterfowl impacts on lost DUDs during the overwintering period of November 1 through February 28.[163] This is an egregious omission because the Yazoo

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[161] DEIS, Appendix F-5 Waterfowl at I.

[162] The Corps' DUD manual states: "is not intended to represent energy needs of waterfowl breeding in the MAV, including some species such as wood ducks, hooded merganser, and some locally-nesting mallards. . . ." Heitmeyer, M. E. 2010. A manual for calculating duck-use-days to determine habitat resource values and waterfowl population energetic requirements in the Mississippi Alluvial Valley: Bloomfield, MO, Greenbrier Wetland Services Report 10-01 (available at https://cw-environment.erdc.dren.mil/models/DUD%20ManualWeb.pdf.) (2010 USACE DUD Manual).

[163] DEIS, Main Report at 143-144 and Appendix A-5. The DUD analysis looks at overwintering energy needs for mallards and 7 other dabbling duck species.

Backwater Area is an important breeding area for waterfowl, and particularly for Wood Ducks and Hooded Mergansers.

Impacts to breeding waterfowl are fully acknowledged in the Clean Water Act veto:

> The proposed project could also affect resident breeding waterfowl, such as wood ducks (*Aix sponsa*) and hooded mergansers (*Lophodytes cucculatus*) (Kaminski, 1998). Both duck species breed in Mississippi and nest in natural tree cavities or artificial nest boxes. Reduced flood pulses in the spring could adversely impact nesting and brood rearing in these birds. These species depend heavily on food resources derived from shallowly flooded forested wetlands (Heitmeyer et al., 2005) and will move their broods to newly flooded bottomland hardwood areas flooded by spring and summer flood pulses, to take advantage of the available plant and animal foods (Kaminski, 1998). Reduction in flooding, due to the project, would adversely impact food resources for these breeding waterfowl (Appendix 4).
>
> The proposed project would reduce the extent of flooding within wetlands in the 2- to 5- year floodplain potentially from January through June. The reductions to late winter and spring flooding would result in significant adverse impacts to those birds which not only utilize the Yazoo Basin, but are dependent upon backwater flooding during these periods (Table 5). As discussed above, species that require flooded habitat for foraging and/or nesting would obviously be the most severely affected. The reduction in the extent and duration of the spring flood pulse would accelerate the decline of many bird species that depend upon the wetland habitats of the lower Yazoo River (Appendix 4).[164]

Critically, as acknowledged in the Clean Water Act veto:

> Population size and recruitment of most species of waterfowl are correlated with wetness of primary breeding habitats, and, at least for some species, also migration and wintering habitats.[165]

Breeding waterfowl also have unique energetic needs that are different from those required by overwintering waterfowl. For example:

> The wood duck is an important resident species in the Yazoo River Basin. Wood ducks require wetland areas that provide a high-quality plant and invertebrate food base. During the breeding season, female wood ducks may use stored lipid reserves to assist with egg production; however, they must consume essentially all of the protein needed for egg formation on a daily basis during the laying period (Drobney, 1977). The required source of most of these proteins is a variety of invertebrates produced in these wetland habitats.[166]

To assess impacts to breeding waterfowl, the DEIS must analyze and account for project-induced impacts during the breeding season—when water levels will be held at their lowest levels—and the unique food sources and energetic needs of breeding waterfowl.

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[164] 2008 Clean Water Act veto at 58.
[165] 2008 Clean Water Act veto at 39.
[166] 2008 Clean Water Act veto at 39.

As noted above, the Yazoo Backwater Area is particularly important for wood duck nesting and rearing. However, Alternatives 2 and 3 will keep water levels at or below the 2-year floodplain precisely when the area wetlands are needed for reproduction. The project-included impacts to wetlands from March through May would impact Wood Duck nesting, whereas project-included impacts to wetlands from June through July could affect Wood Duck broods and post-breeding (molting) females. A diversity of wetland types and water level conditions are needed across space and time during the breeding season to support resilient populations,[167,168] whereas controlling water levels to not exceed 90 feet will add homogeneity to the landscape while reducing the availability suitable habitat.

The wholesale failure to assess impacts to breeding waterfowl renders the DEIS inadequate and prevents decision makers from being able to rely on the DEIS to make a reasoned choice among alternatives. The final EIS must assess impacts to breeding waterfowl. To do this, DEIS could use methodologies similar to those used in the other bird models, such as a Habitat Suitability Index approach, which are available for both Wood Duck[169] and Hooded Merganser,[170] but ideally would use more advanced methodologies.

(b) The DEIS Does Not Assess or Account for Impacts to Migrating Waterfowl

The DEIS does not assess or account for impacts to waterfowl during the critical spring and fall migration seasons. Instead, the DEIS bases its entire analysis of waterfowl impacts on lost DUDs during the overwintering period of November 1 through February 28.[171] This is an egregious omission since the Yazoo Backwater Area is an important stopover area for waterfowl that migrate through the Mississippi River Flyway during the spring and fall migrations.

Because of this unacceptable omission, the DEIS:

- **Does not provide any information on impacts during spring migration, when 1.49 million waterfowl migrate through the Yazoo Backwater Area; and**

- **Does not provide any information on impacts during fall migration, when 1.32 million waterfowl migrate through the Yazoo Backwater Area**.

At least sixteen different species of waterfowl rely on the Yazoo Backwater Area during migration, including economically important species like the Blue-winged Teal, which migrates through the region particularly early in the fall and late in the spring.

To properly assess impacts to migrating waterfowl, project-induced impacts must be assessed during the spring migration and fall migration seasons—when water levels will be held at their lowest levels—and

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[167] Hartke, K. M. and G. R. Hepp. 2010. Habitat use and preferences of breeding female Wood Ducks. Journal of Wildlife Management 68(1):84-93.
[168] Dugger, B.D. K.M. Dugger, and L.H. Fredrickson. 2020. Hooded Merganser (*Lophodytes cucullatus*), version 1.0. In Birds of the World (A. F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.hoomer.01
[169] Sousa, P.J. and A. H. Farmer. 1983. Habitat Suitability Index Models: Wood Duck. FWS/OBS Report 82/10.43. U.S. Fish and Wildlife Service, 27 pp. https://pubs.usgs.gov/publication/fwsobs82_10_43
[170] Hooded Merganser Predicted Habitat – CWHR B104 [ds2078] https://map.dfg.ca.gov/metadata/ds2078.html
[171] DEIS, Main Report at 143-144 and Appendix A-5. The DUD analysis looks at overwintering energy needs for mallards and 7 other dabbling duck species.

must properly account for the unique food sources and energetic needs of migrating waterfowl.[172] For example, during spring migration waterfowl must accumulate both the resources they need to fuel their northward migration and the resources they need to carry over into egg laying production which will affect breeding productivity. The energetic demands of waterfowl in spring are thus considered the most limiting period in the life cycle of waterfowl, and this period has a disproportionate effect on population change. Population size and recruitment for some waterfowl species "are correlated with wetness" of migration habitat, as recognized in the Clean Water Act veto.[173]

The Yazoo Backwater Area is particularly critical to migratory waterfowl from early March through mid-April (spring migration) and mid-August through late October (fall migration). To assess impacts during this period, the DEIS must assess impacts during both migratory seasons using appropriately protective energetic values. Under the current DUD assessment, **approximately 124 days** of migratory impacts are **not** assessed.[174,175]

(c) The DEIS Does Not Assess or Account for Multiple Adverse Impacts to Waterfowl

The Corps may not properly rely solely on an assessment of lost DUDs (even one that fully addresses the problems highlighted above). To the contrary, the DEIS must assess waterfowl impacts in light of the full suite of direct, indirect, and cumulative impacts. As highlighted in the Clean Water Act veto:

> The impacts to waterfowl are related to long-term, adverse impacts to spring breeding and rearing habitat for species such as the wood duck and hooded merganser, as well as the reductions in spring flooding that ultimately, over time, alter the flora and fauna that waterfowl depend on during the breeding and wintering period.[176]

(e) The DEIS May Not Rely Solely on DUD Model Outputs to Identify Needed Mitigation

The DEIS may not rely solely on the DUD Model outputs to identify needed mitigation Because the model can at best provide an estimate of relative loss and not a precise prediction of lost duck use days.

The DEIS relies entirely on lost DUDs to identify needed mitigation. This is not appropriate because at best, a DUD model will provide an <u>estimate</u> of relative losses. Even a perfectly implemented DUD model will <u>not</u> provide a precise prediction of lost duck use days. For example, the DUD model relies on a series of estimates that offer an unknown amount of precision and error to predict current and future conditions in the Yazoo Backwater Area, as documented in the Corps' May 2010 "Manual for Calculating

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[172] The Corps' Manual for Calculating Duck-Use-Days also emphasizes the need to calculate DUDs from September through March. USACE 2010 DUD Manual.
[173] Clean Water Act Veto at 39.
[174] For Alternative 2, the current DUD assessment does not evaluate impacts during the migratory season from: 30 days of pumping to 93 feet—March 1 through March 15 (spring migration) and October 16 through October 31 (fall migration); and does not evaluate 93 days of pumping to 90 feet—March 16 through April 15 (spring migration) and August 15 through October 15 (fall migration).
[175] For Alternative 3, the current DUD assessment does not evaluate impacts during the migratory season from: 40 days of pumping to 93 feet—March 1 through March 24 (spring migration), and October 16 through October 31 (fall migration); and does not evaluate 84 days of pumping to 90 feet—March 25 through April 15 (spring migration), and August 15 through October 15 (fall migration).
[176] 2008 Clean Water Act veto, Appendix 1 at 61.

Duck-Use-Days to Determine Habitat Resource Values and Waterfowl Population Energetic Requirements in the Mississippi Alluvial Valley."[177] For example:

> Estimates of food abundances reported in the field studies considered in this manual often varied substantially, and ranges of values and error probability were not always reported. This manual provides estimates of food abundance and availability to be used in model equations based on statistical means/medians of similar studies and/or data from more comprehensive and long-term investigations. For some foods and habitats, few data/studies were available and estimate values were chosen based on assumed relationships of other similar foods or habitats. . . .Consequently, it is difficult to suggest exact probability values, such as standard of errors, for the selected estimates of specific foods and habitats.[178]

The 2010 DUD Manual thus makes clear that uncertainties remain regarding how to measure food production of various habitats, which also varies by season and geography. This adds to the uncertainties in the model's output of DUD estimates.

The DUD model also requires multiple project specific inputs, which may themselves be based on estimates:

> Project-specific information including number and species of waterfowl present; area, type, and management of habitats; composition, density and size of trees in forested habitats; and occurrence, frequency and duration of flooding by area and habitat type is required prior to using the model equations provided in this manual.[179]

Errors in any of the many required inputs will contribute to uncertainties in the model's outputs. As a result, although relative losses in DUD can be calculated to inform mitigation, mitigation based on calculated DUD losses cannot ensure full mitigation of impacts (even if that mitigation was 100% successful in replacing lost functions and values).[180]

Many additional problems with the proposed waterfowl mitigation are discussed throughout this Section and in Section L of these comments. Notably, these problems are not nullified or offset in any way by the Corps' completely unsupported hypothesis that the "potential for creating moist-soil management units using structural means or green-tree reservoirs along with enhancing bottomland hardwood forests (BLH) will more than offset the loss of foraging habitat to wintering waterfowl in the Yazoo Basin with proper mitigation to compensate for the loss of DUD under the Water Management Plan."[181]

The Conservation Organizations also note that the DEIS creates confusion and inappropriate burdens on the reviewing public by including two separate Waterfowl Appendices—Appendix F-5, which is discussed

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[177] USACE 2010 DUD Manual.
[178] USACE 2010 DUD Manual at 4.
[179] USACE 2010 DUD Manual at 4.
[180] The DEIS also appears to rely on the voluntary "acquisition and revegetation of up to approximately 11,816 acres of frequently flooded agricultural land below 90-feet in elevation through implementation of the non-structural features" to provide "significant overall benefits to waterfowl resources." DEIS, Main Report at 143, 144. However, as extensively documented in the Clean Water Act veto, voluntary measures are not mitigation.
[181] DEIS, Appendix F-5 Waterfowl at I.

below; and Appendix F-4, D. These appendices also create confusion including by such things as failing to properly clarify whether the amount of proposed mitigation is required annually or over the life of the project, utilizing tables with confusing formatting, and presenting graphs without axis labels, among other things. These appendices create additional confusion by using different labels for the same alternative. For example, the two waterfowl appendices variously describe both the No Action Alternative and the alternative with a crop season that runs from March 25-October 15 as Alternative 1[182] and the alternative with a crop season that runs from March 15-October 15 as Alternative 2.[183] By comparison, the DEIS Main Report refers to Alternative 1 as the No Action Alternative, Alternative 2 as having a crop season of March 16-October 15, and Alternative 3 as having a crop season of March 25-October 15.[184]

As discussed throughout these comments, the DEIS does not assess a wide array of highly relevant direct, indirect, and cumulative impacts. For example, the DEIS does not evaluate the cumulative impacts of climate change which are particularly significant for migratory species and does not evaluate the cumulative impacts of habitat loss throughout the waterfowl species' migratory routes. This full array of impacts must be accounted for in assessing the highly significant impacts of Alternatives 2 and 3 on waterfowl that rely on the Yazoo Backwater Area.

2. The DEIS Shorebird Analysis is Fundamentally Unreliable (Appendix F-4, B)

The DEIS incorrectly assesses impacts to shorebirds.[185] This is an egregious error because the Yazoo Backwater Area provides vital shorebird habitat during the spring and fall migration, as highlighted by the Clean Water Act veto.[186]

Approximately **6.6 million shorebirds** from 17 species migrate through the Yazoo Backwater Area in the fall, while **2.8 million** migrate through the Yazoo Backwater Area in the spring, according to Audubon's analysis. **More than 10% of the continental population** of several of these shorebird species rely on the Yazoo Backwater Area. This diverse suite of birds depends on often ephemeral habitat resulting from wet-dry cycling that produces high concentrations of invertebrates. All these species prefer moist soil and shallow water, although a few species will also sometimes feed in dry grassy habitats (e.g., American Golden-Plover).

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[182] Compare DEIS, Appendix F-5, Waterfowl at II and 8.

[183] DEIS, Appendix F-5, Waterfowl at II.

[184] DEIS, Main Report at 32-34.

[185] The DEIS contends that the just 37 shorebird average annual habitat units would be lost under Alternative 2 or Alternative 3, that could be mitigated by "acquisition of approximately 43 acres of open land (*e.g.*, agricultural land) with water management capabilities that maintain open wet substrate with sparse vegetation would offset impacts to shorebirds." DEIS Main Report at 141-42.

[186] Clean Water Act 404(c) Final Determination at 26 ("…500,000-1,000,000 shorebirds, migrate on a biannual basis. FWS also notes that natural springtime flooding in the area's riverine backwater wetlands coincides with two major events in the LMRAV: 1) native bird and waterfowl migration that requires suitable and productive stopover and foraging habitats to meet migratory energy needs; and 2) breeding bird and waterfowl nesting that requires adequate nesting and foraging habitats to meet reproductive and rearing needs."). The shorebird numbers highlighted in the veto may well be an underestimate, as indicated by Audubon's more recent analysis of shorebird use in the region.

Despite the unquestionable importance of the Yazoo Backwater Area to shorebirds, the DEIS suffers from critical flaws that render its shorebird assessment fundamentally unreliable. A number of these flaws are highlighted below.

First, the DEIS does not properly identify[187]—or assess the impacts to—shorebird species that are more reliant on the Yazoo Backwater Area. Based on the Audubon analysis, the region is most important for the species listed below. More than 1% of continental populations of the species on this list that are highlighted in blue rely on the Yazoo Backwater Area during both the spring and fall migration:

- **>5% of continental population in spring**: **Pectoral Sandpiper, Lesser Yellowlegs,** American Golden-Plover, White-rumped Sandpiper, **Stilt Sandpiper, Least Sandpiper, Semipalmated Sandpiper,** Greater Yellowlegs

- **1-5% of continental population in spring**: **Long-billed Dowitcher,** Dunlin, **Short-billed Dowitcher**, Solitary Sandpiper, **Semipalmated Plover**

- **>5% of continental population in fall**: **Least Sandpiper, Pectoral Sandpiper, Long-billed Dowitcher, Stilt Sandpiper, Lesser Yellowlegs, Semipalmated Sandpiper, Short-billed Dowitcher**, Black-necked Stilt, Western Sandpiper

- **1-5% continental population in fall**: American Avocet, Solitary Sandpiper, **Semipalmated Plover**, Wilson's Snipe, Spotted Sandpiper.

Second, the DEIS relies on a shorebird model that does not—and cannot—capture the important nuances in shorebird habitat requirements. For example, migratory shorebirds have unique habitat needs because they are highly transient, with individual birds stopping only as long as they need (a few days to a few weeks) to continue migrating. Thus, to provide a meaningful analysis, a shorebird model must be able to assess whether habitat will be available at the times when these shorebird "waves" pass through the Yazoo Backwater Area. To provide a meaningful analysis, a shorebird model also must be able to assess whether the highly ephemeral food sources that shorebirds rely on will be present in those available habitats when these shorebird waves pass through. These food sources are generated by repeated cycles of flooding and drying, so the model must be able to account for the transient presence or absence of water on the land during these cycles. Models that can assess these nuances are available, including the model presented in Twedt (2013)[188], and should be used to assess the impacts of the Yazoo Pumps Alternatives on shorebirds.

Third, the Corps parameterizes its already inappropriate shorebird model with severely flawed assumptions that do not reflect the ecological needs of migratory shorebirds. This makes the shorebird model outputs fundamentally unreliable. For example, the Corps' shorebird model only provides a binary choice of habitat suitability, with suitable habitat having an "average" water depth of 0.0 – 0.7 feet. Among other problems, by including an "average" water depth of 0.0 feet as suitable, the model is accounting for dry land as suitable shorebird habitat. But dry land is not shorebird habitat. Relying on average water depths also means that the model cannot account for the crucial importance of

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[187] DEIS, Main Report at 92. While the list of "common shorebirds" in the DEIS is accurate, this list does not reflect the shorebirds that are most reliant on the Yazoo Backwater Area.

[188] Twedt, D.J. Foraging Habitat for Shorebirds in Southeastern Missouri and its Predicted Future Availability. Wetlands 33, 667–678 (2013). https://doi.org/10.1007/s13157-013-0422-0.

ephemeral habitat. By failing to indicate whether the "average" represents a mean or median, the DEIS creates additional problems for interpreting the accuracy of the model outputs.

The model's reliance on averaging (i.e., combining) impacts between spring and fall, is a critical and fundamental failing. By averaging spring and fall impacts, the model is not able to identify the impacts of the Yazoo Pumps Alternatives on shorebird during the most critical and limiting period of the shorebird life cycle—fall migration. Understanding the fall migration impacts is essential to accurately assessing shorebird impacts because the region's fall migration habitat is extremely limited at the precise time that it is most needed by the extremely large number of shorebirds that migrate through the area during that time. Approximately **6.6 million shorebirds** from 17 species migrate through the Yazoo Backwater Area in the fall when habitat is the most limited: "shallow-water habitats during the southern migration period of shorebirds are extremely limited in the Mississippi Alluvial Valley, and early fall habitat is generally more limited than is late fall habitat."[189] During the spring, when more shorebird habitat is available[190], approximately **2.8 million** shorebirds migrate through the Yazoo Backwater Area.

Some of the problems with the approach taken in the DEIS shorebird model are highlighted in the two scenarios presented in the table below.

Time Period	Pixel A	Pixel B
1	0.1	0.1
2	0.1	0.1
3	0.1	0.0
4	0.1	0.1
5	0.1	0.0
6	0.1	0.1
7	0.1	2.0
8	0.1	1.8
9	0.1	1.8
10	1.8	1.8
Mean	**0.3**	**0.8**
Median	**0.1**	**0.1**

Pixel A is considered suitable habitat in the model when considering both the median and the mean. Pixel B is considered suitable only if considering the median, but not the mean. Under these scenarios, Pixel A and Pixel B are both flooded to different depths over 10 different time periods. Ecologically, both Pixel A and Pixel B would provide suitable habitat because they provide appropriate water depths more than 50% of the time, but Pixel B is ecologically superior because it goes through two phases of drying and flooding, which provides key ephemeral food resources on which migratory shorebirds depend. However, based on our analysis, the DEIS shorebird model would consider Pixel A suitable and Pixel B unsuitable, an outcome that is not supported by underlying ecological principles.

[189] Brown, S., C. Hickey, B. Harrington, and R. Gill, eds. 2001. The U.S. Shorebird Conservation Plan, 2nd ed. Manomet Center for Conservation Sciences, Manomet, MA.
[190] DEIS, Main Report at 91 (4.2.2.3.4 Shorebirds).

Fourth, the shorebird model relies on outputs from the EnviroFish model. Indeed, the EnviroFish model outputs are foundational to the shorebird model.[191] As a result, the shorebird model will be infected by any problems with EnviroFish, including those identified in Section G of these comments.

Fifth, to fully analyze shorebird impacts, the model would also need to evaluate the loss of shorebird habitat that would arise from those elements of the proposed compensatory mitigation that would reforest low elevation agricultural lands that currently provide shorebird habitat, because shorebirds will not use forested habitats.[69]

Sixth, the DEIS shorebird analysis lacks transparency, making it difficult to assess the full range of the potential problems with the model. For example, the DEIS provides little information on this functionality, and the Conservation Organizations were unable to locate the report on the "Shorebird Migration Model" referred to the DEIS[192] despite an extensive search. The "in-house" hydrology layers referenced in Table B-2 also are not available for the public to review.

The write-up of the shorebird model also creates confusion. For example, it is unclear whether the Shorebird Appendix concludes that 403 acres of shorebird habitat are needed each year or whether that amount is needed cumulatively over the life of the project. It is also unclear whether mitigation has been assessed over a 50-year project life or over the 43-year period of record which is what the math in Table B-6 suggests. It is unclear when (i.e., fall and/or spring) and how mitigation for lost Habitat Units would be implemented. The DEIS also uses multiple different labels to describe the same alternative.

Seventh, the Corps may not properly rely solely on outputs from a shorebird model to assess shorebird impacts, even if the DEIS used an appropriate shorebird model populated with accurate information. The DEIS must assess and account for shorebird impacts in light of the wide array of direct, indirect, and cumulative impacts that will adversely affect shorebirds and the Yazoo Backwater Area. Cumulative impacts to habitat throughout a species' migratory route and the cumulative impacts of climate change are particularly significant for migratory species, including migratory shorebirds. This full array of impacts must be accounted for in assessing the highly significant impacts of Alternatives 2 and 3 on the shorebirds that rely on the Yazoo Backwater Area.

As a result of these many failings, the DEIS assessment of shorebird impacts is fundamentally unreliable.

3. The DEIS Significantly Understates Impacts to Wading Birds (Appendix F-4, C)

The DEIS significantly understates impacts to the region's important populations of wading birds[193], including by basing its entire assessment on potential impacts to a single unrepresentative species during a single stage of its lifecycle. Multiple problems with the DEIS wading bird analysis are highlighted below.

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[191] DEIS, Appendix F-4 at 5.

[192] DEIS, Appendix F-4, B (Shorebirds) at 55 (referencing Clark, Steven J. and Joseph W. Jordan. 2017. Shorebird Migration Model. U. S Army Corps of Engineers, St Paul District. St. Paul, MN. 21pp. We used the Shorebird Migration Model (Clark and Jordan, 2017)).

[193] The DEIS contends that 714 GBHE average annual habitat units would be lost under Alternative 2, which could be mitigated through reforestation of 793 to 2,805 acres of agricultural fields, depending on location. Alternative 3 would cause the loss of 698 GBHE average annual habitat units that could be mitigated through reforestation of 776 to 2,742 acres of agricultural fields, depending on location. DEIS, Main Report at 141-142.

First, the wading bird analysis is flawed because it relies on just a single, unrepresentative species—the Great Blue Heron (GBHE)—to assess impacts to the region's important populations of wading birds. The GBHE is not an appropriate umbrella (or surrogate) species for other wading birds because the GBHE utilizes a wide variety of foraging habitats.[194] As a result, the loss of subcomponent of GBHE niche habitat space might have only minimal effect on GBHE even though it could cause highly significant impacts to the wide array of species the GBHE was chosen to represent. This problem is highlighted in meta-analyses of the umbrella species concept because "some species are inevitably limited by ecological factors that are not relevant to the umbrella species."[195]

Critically, the DEIS uses GBHE to represent species that the GBHE in fact does not represent, including species that are highly reliant on the Yazoo Backwater Area such as the ibis, Little Blue Heron, Snowy Egret, Yellow-crowned Night Heron, and Tricolored Heron. During the fall, the Yazoo Backwater Area supports: 4.3% of the continental population of Snowy Egret; 9.2% of the continental of Yellow-crowned Night Heron; and 3.7% of the continental population of the Tricolored Heron.

The selection of the GBHE as the umbrella species also violates important criteria for selecting an umbrella species which include rarity, sensitivity to human disturbance (e.g., habitat alterations), and relative co-occurrence with other species for which it is an assumed proxy.[196] However, the GBHE is neither rare nor particularly sensitive to habitat modifications in comparison to many other wading bird species. The DEIS offers no quantitative measures or description of how or why the GBHE was chosen as the umbrella species.

Second, the DEIS only analyzes impacts to GBHE habitat during a single stage of its lifecycle: the breeding season. The DEIS does not analyze or consider impacts to GBHE or any wading bird habitat during other periods of the life-cycle, including the critically important: (1) post-breeding season, typically from July through early September when waterbirds and especially young birds will travel north/northeast in search of flooded wetlands—during this period water on the landscape is limiting, and water would be further limited by the seasonal pumping scenarios of the Yazoo Pumps Alternatives; (2) fall migration from September through mid-November; and (3) over-wintering period from November through mid-March.

Impacts during these other periods could be significant. For example, by keeping water levels at or below 90 feet during the late-summer the Yazoo Pumps Alternatives could cause substantial impacts to critically important populations of several species of wading birds that are heavily reliant on the Yazoo Backwater Area, including the Snowy Egret, Yellow-crowned Night Heron, and Tricolored Heron.

Third, the DEIS infuses an inappropriate bias into its analysis by irresponsibly suggesting—without any factual support whatsoever—that there may be unaccounted for benefits to wading birds from the Yazoo Pumps Alternatives.[197] This suggestion is even more unacceptable because the DEIS does not

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[194] See, e.g., DEIS, Appendix F-4, C (Great Blue Heron Habitat Assessment) at 68.
[195] Roberge, J.-M., and P. Angelstam. 2004. Usefulness of the umbrella species concept as a conservation tool. Conservation Biology 18(1):76-85.
[196] Fleishman, E., D.D. Murphy, P.F. Brussard. 2000. A new method for selection of umbrella species for conservation planning. Ecological Applications 10(2):569-597.
[197] DEIS, Appendix F-4, C (Great Blue Heron Habitat Assessment) at 86 ("It is important to note that this report only considers alterations with hydrology between base and alternative scenarios that contribute to losses of habitat

consider impacts to wading birds outside of the nesting season, which could significantly offset any such unsupported benefits, as discussed above.

Fourth, the wading bird model relies on outputs from the EnviroFish model. Indeed, the EnviroFish model outputs are foundational to the wading bird model.[198] As a result, the wading bird model will be infected by any problems with EnviroFish, including those identified in Section G of these comments.

Fifth, the DEIS wading bird analysis lacks transparency, making it difficult to ass the full range of the potential problems with the model. For example, the DEIS fails to provide an explanation of why it is appropriate to use the National Elevation Dataset instead of the more up to date USGS 3D Elevation Program (3DEP).[199] The DEIS fails to explain why there is an order of magnitude difference in flooded acres under the mean versus the median. It is also not clear which (median or mean) was used in the HSI model, and the biological and analytical implications of using one over the other is critical for interpreting potential impacts. Additional points of confusion in the wading bird section include the lack of x- and y-axis labels in Figure C-3, and Table C-6 is missing site numbers (#6 and #7). As iterated elsewhere in our comments, the general incomplete and draft presentation of this and other sections in Appendix F-4 suggests a lack of thorough attention and review.

Sixth, the Corps may not properly rely solely on outputs from a wading bird model to assess shorebird impacts, even if the DEIS used an appropriate wading bird model populated with accurate information. The DEIS must assess and account for wading bird impacts in light of the wide array of direct, indirect, and cumulative impacts that will adversely affect wading birds in the Yazoo Backwater Area. This full array of impacts must be accounted for in assessing the impacts of Alternatives 2 and 3 on the wading birds that rely on the Yazoo Backwater Area.

As a result of these many failings, the DEIS significantly understates wading bird impacts.

4. The DEIS Significantly Understates Impacts to Secretive Marsh Birds (Appendix F-4, E)

The DEIS analysis of impacts to secretive marsh birds[200] is fundamentally flawed and cannot be relied upon. Multiple problems with the DEIS wading bird analysis are highlighted below.

First, the DEIS marsh bird model identifies habitat types that do not provide marsh bird habitat as providing suitable habitat for marsh birds. For example, the model includes "Eastern Warm Temperate Developed Herbaceous and "Eastern Warm Temperate Urban Herbaceous"[201] (as defined in the Landfire

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and does not attempt to quantify any benefits that may be gained from drawdowns or perhaps other potential beneficial factors of pumping, such as preventing hypoxia (that can lead to fish die-offs and thus decrease GBHE food availability) in long-standing floodwaters or reducing accumulation of environmental contaminants (e.g., methylmercury) as a result of the operation of the pumps.").

[198] DEIS, Appendix F-4 at 5.

[199] DEIS, Appendix F-4 at 71.

[200] The DEIS contends that "there will be only minor losses in marsh bird habitat under the alternative scenarios" and that as result, mitigation for marsh birds "is not calculated." The DEIS also contends, without explanation, that "losses in marsh bird habitat under the alternative action were almost completely balanced by gains in habitat." DEIS, Appendix F-4, Secretive Marsh Bird Appendix E at 46.

[201] DEIS, Appendix F-4 at 39.

(2022) and Cropscape (2023) databases[202]) as providing marsh bird habitat. However, the Landfire database defines these habitat types as "Urban/Developed Grassland" which is **not** marsh bird habitat.

Second, the DEIS marsh bird model (like the shorebird model) relies on lands with a seasonal average of 0.0 feet of flooding as marsh bird habitat. This is fundamentally inappropriate because areas with 0.0 feet of flooding are dry land and thus, unsuitable for marsh birds.

Third, the DEIS marsh bird model includes a range of 0 to 18 inches of flooding as providing suitable habitat. Relying on this range further dilutes the model's ability to detect the specific needs of individual marsh bird species, such as between King Rails and Common Gallinules, which live on different ends of the wetland water depth spectrum. This reliance prevents the model from being able to detect whether the needs of specific species or a marsh bird community structure would be impacted by the Yazoo Pumps Alternatives.

Fourth, the DEIS fails to provide an accurate assessment of the amount of marsh bird habitat in the Yazoo Backwater Area. For example, the DEIS lumps together more than 10% of habitat as "other" which the DEIS defines as being "comprised of lands around the edges of other land cover types, cloud cover, undefined, and scrublands."[203] This "other" habitat could include a significant amount of marsh bird habitat—and likely far more than the total marsh bird habitat identified in the DEIS. There are approximately 7,000 acres of "other" habitat types between the 90- and 93-foot elevation and approximately 16,000 acres of "other" habitat types the 93- and 98.2-foot elevations. Despite this extensive acreage of possible marsh bird habitat, DEIS Table 3-3 identifies just 164 acres of marsh bird wetland habitat between 90 and 93 feet, and just 93 acres between 93 and 98.2 feet.

Fifth, the DEIS has appears not to have relied on accurate assessments of secretive marsh populations in the Yazoo Backwater Area, which would skew the assessment of impacts. For example:

- The DEIS marsh bird analysis appears to be relying at least in part on IPaC to determine population levels in the Yazoo Backwater Area.[204] However, IPaC must be used with caution as it does not provide a definitive tool for determining the presence/absence of species. Instead, IPaC is based on the expected range of each species (to serve its primary purpose of encouraging consultation with the U.S. Fish and Wildlife Service). Specifically, IPaC states:

  > "The primary information used to generate this list is the known or expected range of each species. Additional areas of influence (AOI) for species are also considered. An AOI includes areas outside of the species range if the species could be indirectly affected by activities in that area (e.g., placing a dam upstream of a fish population even if that fish does not occur at the dam site, may indirectly impact the species by reducing or eliminating water flow downstream). Because species can move, and site conditions can change, the species on this list are not guaranteed to be found on or near the

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[202] It is also unclear how these and other cover classifications used in the DEIS shorebird model were reconciled across the Cropspace and Landfire data.
[203] DEIS, Main Report at 28 (Table 3-3).
[204] The DEIS uses the terminology "IPaC and BoCC Results", however these are not results but simply a cross-referencing of the (incorrect) species list against two databases. Additional background and justification for relying on the IPaC system is also required.

project area. To fully determine any potential effects to species, additional site-specific and project-specific information is often required."[205]

- Although the DEIS recognizes the importance for conducting standardized marsh bird surveys, the secretive marsh bird appendix relies merely on species-specific summaries of eBird data, which clearly do not approach the rigor of standardized marsh bird surveys. Further, the raw eBird numbers provided in the DEIS do not match the information in the eBird public-facing database. eBird includes both "confirmed" and "unconfirmed" records. Unconfirmed records are not available in the public-facing maps and bar charts but are available from the database. Analyses that utilize eBird data should specify what was retrieved (spatial and temporal bounds) and when the data was retrieved (as historic records can always be added later). This is perhaps of little consequence, however, because importantly, a more appropriate way to use eBird for assessing the status of marsh birds in the region would be by reviewing their peer-reviewed Science portal and examine eBird predictive distribution maps rather than using raw eBird outputs. This is particularly important for the DEIS marsh bird analysis because the region is under-birded and secretive marsh birds are notoriously difficult to detect, as the DEIS acknowledges.

- The DEIS also provides incorrect information on the methods that could be used to carry out standardized marsh bird surveys, which is important for understanding the Corps could have in fact carried out such surveys to improve its analysis. The DEIS does not rely on (and presumably the Corps did not carry out) surveys to assess marsh bird population numbers, stating instead that "Typical avian sampling methods such as point count or transect surveys are unlikely to result in detection of these species. However, most secretive marsh birds, particularly rails, often respond to play-back recordings."[206] This is an oversimplified statement, and all species of marsh birds can absolutely be detected without the use of playback, especially during the peak of breeding early in the morning or late in the evening. The use of playback in standardized marsh bird surveys is instead recommended to improve detection rates, thus making the detection-per-unit-effort of playback-based surveys more efficient and effective, and improving a researcher's ability to generate occupancy or density estimates.[207] The DEIS should use language that correctly disseminates how and why such datasets might be collected in order to help the public understand limitations in the evaluation of the project Alternatives on marsh birds as presented in the DEIS, given that no standardized marsh bird datasets currently exist for the Yazoo Backwater Area.

The DEIS list of eight species of secretive marsh birds expected in the region is incorrect. Clapper Rail should be removed from consideration, and Least Bittern, American Bittern, Pied-billed Grebe, and

[205] Pac Website, "**What does IPaC use to generate the list of endangered species potentially occurring in my specified location?"** https://ipac.ecosphere.fws.gov/location/RO7DGZ7KWFC7JJR64TZ27WD6KM/resources.
[206] DEIS, Appendix F-4 at 37.
[207] Conway, CJ. 2015. National protocol framework for the inventory and monitoring of secretive marsh birds. Inventory and Monitoring, National Wildlife Refuge System, U.S. Fish and Wildlife Service, Fort Collins, Colorado. https://ecos.fws.gov/ServCat/DownloadFile/101125.

American Coot should be added, resulting in a list of 11 species. See USFWS National Protocol Framework for the Inventory and Monitoring of Secretive Marsh Birds.[208]

Sixth, the DEIS secretive marsh bird analysis lacks transparency, making it difficult to ass the full range of the potential problems with the model, and the secretive marsh bird write-up is confusing.

Seventh, the DEIS does not assess or account for the impacts to secretive marsh birds in light of the full suite of direct, indirect, and cumulative impacts that will adversely affect secretive marsh birds that rely on the Yazoo Backwater Area. The DEIS may not properly rely solely on outputs from a secretive marsh bird model to assess marsh bird impacts, even if the DEIS used an appropriate model populated with accurate information.

As a result of these many failings, the DEIS significantly understates secretive marsh bird impacts.

5. The DEIS Significantly Understates Impacts to Migratory Landbirds (Appendix F-4, A)

The DEIS significantly understates impacts to migratory landbird species[209], including because it does not assess impacts during migratory and over-wintering periods. Numerous problems with the migratory landbird analysis are highlighted below.

First, the migratory landbird analysis does not assess impacts during the migration and over-wintering periods. The DEIS only looks at potential landbird impacts during the period from March 15 through July 31.[210] Among other things, this means that the DEIS: has not assessed impacts to the Rusty Blackbird, which is one of the fastest declining birds in North America (about 90% since the 1960s) and is extremely sensitive to drying and flooding during the non-breeding season; and has not assessed impacts to the Golden-winged Warbler, which is a candidate species under the Endangered Species Act that migrates through the region in spring and fall.

Second, the results of the migratory landbird assessment appear to be inconsistent with the conclusions in the DEIS that the Yazoo Pumps Alternatives would affect 89,839 to 93,306 acres of wetlands, depending on the final alternative selected. Despite these extensive wetland impacts, most of which will occur in bottomland hardwood wetlands, the landbird assessment suggests that there will only be minimal impacts to forested wetland dependent landbirds like the Prothonotary Warbler (PROW) and Acadian Flycatcher. A more in-depth presentation of the analysis, especially its hydrological inputs and assumptions, is needed to understand this and other rather apparent and substantial inconsistencies.

For example, as acknowledged in the DEIS: "The PROW is a cavity-nesting species dependent on forested wetland habitats (Petit 2020). This species is common to abundant in forested areas along the Mississippi River and in the YBA along forested rivers, creeks, oxbows, sloughs, and other depressional

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[208] Conway, CJ. 2015. National protocol framework for the inventory and monitoring of secretive marsh birds. Inventory and Monitoring, National Wildlife Refuge System, U.S. Fish and Wildlife Service, Fort Collins, Colorado. https://ecos.fws.gov/ServCat/DownloadFile/101125.

[209] The DEIS contends that the Yazoo Pumps Alternatives would result in the loss of: 694 average annual habitat units for the Prothonotary Warbler that could be offset by approximately 1,056 acres of bottomland hardwood reforestation; and 146 annual habitat units for the Acadian Flycatcher could be offset by approximately 444 acres of bottomland hardwood reforestation. DEIS, Main Report at 140, 142.

[210] DEIS, Appendix F-4, A (Migratory Landbirds) at 28.

wetlands, especially those that hold water during the breeding season. Because of their dependence on these floodplain features, they are a good indicator species for many of the wetland-dependent birds in the YBA.[211] Given this this wetland dependency and the extensive wetland acreage (including woody wetlands) that will be adversely impacted by the Yazoo Pumps Alternatives, the model's conclusion that PROW impacts could be offset by just 1056 acres of bottomland hardwood reforestation is questionable, and at a minimum requires additional explanation.

Understanding impacts to PROW is particularly important as the Yazoo Backwater Area has one of the most important concentrations of this species in the region (eBird relative abundance indices >1.2), on par with other critical places like Tensas National Wildlife Refuge. PROW populations have been increasing in the region between 2012 and 2022, despite the long-term 50-year trend that shows a 29% decline in PROW according to the U.S. Geological Survey Breeding Bird Survey, indicating the relative high value of the Yazoo Backwater Area in sustaining this species.[212]

Third, the DEIS migratory landbird analysis lacks transparency, making it difficult to assess the full range of the potential problems with the model, and the migratory landbird write-up is confusing. For example:

- The landbird appendix refers to Acoustic Recording Unit data but does not explain the purpose of this data or how it links to the DEIS assessments. The appendix mentions many "thousands of hours" of recordings but does not provide information on what those recordings show or whether they are representative of species density. The appendix states that acoustic recording sampling between the 92.8- and 97.3-foot elevations was "representative" but does not explain how or why, and of course this does not include the area between 90 and 93 feet which will be extensively impacted by the Yazoo Pumps Alternatives. Moreover, the fact that there are many thousands of Prothonotary Warbler and Acadian Flycatcher detections above 93 feet suggests that the impacts to these species from reduced periodic flooding (i.e., long-term drying) above 93 feet may not be properly accounted for in the landbird model since the model suggests that there will be extremely limited impacts to these species above 93 feet, again calling into question the difference between the model outputs and estimated wetland drainage presented elsewhere in the DEIS.

- The landbird appendix refers to a two-week late July visit to the region to detect bird species but does not explain how or why this was an appropriate time to collect such data, or how these surveys might contribute to an understanding of habitat impacts to landbirds. It is more likely that this was an inappropriate time to collect data as songbirds become quieter during this period as they tend to fledglings, molt, and prepare to migrate south.

- The appendix states that "the YBA consists largely of agricultural lands with scattered remnants of BLH and cypress/tupelo swamps (Wakeley 2007)."[213] This contradicts DEIS Table 3-3 which shows substantially more wetland forest than agriculture, at least below the flood inundation thresholds being evaluated in the DEIS.

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[211] DEIS, Appendix F-4, A (Migratory Landbirds) at 10.
[212] Sauer, J.R., Link, W.A., and Hines, J.E., 2020, The North American Breeding Bird Survey, Analysis Results 1966 - 2022: U.S. Geological Survey data release, https://doi.org/10.5066/P96A7675.
[213] DEIS, Appendix F-4, A (Migratory Landbirds) at 11.

- Table A-6 does not explain whether the "average" is the mean or the median, which can have significant implications for the interpretation of the data. Figures A-1, A-2, and A-3 document large gaps in the two large, forested blocks in the southern portion of the Yazoo Backwater Area without any corresponding explanation.

Fourth, the DEIS does not assess or account for the impacts to migratory landbirds in light of the full suite of direct, indirect, and cumulative impacts that will adversely affect migratory landbirds that rely on the Yazoo Backwater Area. The DEIS may not properly rely solely on outputs from a migratory landbird model to assess landbird impacts, even if the DEIS used an appropriate model populated with accurate information.

As a result of these many failings, the DEIS significantly understates migratory landbird impacts.

G. The DEIS Understates Impacts to Fisheries

The DEIS understates impacts to fisheries and understates the amount of mitigation needed to offset those impacts. Among other problems, the EnviroFish analysis relies on modeling parameters specifically rejected by the Clean Water Act veto and masks the effect of operating the Yazoo Pumps Alternatives by assessing and then averaging impacts across the full period of record—even during the many years when the Yazoo Pumps would not have been operating. The DEIS also states that it will only implement 55% of the amount of the recommended mitigation.[214]

According to the DEIS, Alternative 2 would result in an estimated loss of "2,264 and 1,862 HUs for spawning and rearing, equivalent to a reduction of **3,969 and 3,721 Average Daily Flooded Acres**, respectively. To compensate for direct and indirect impacts associate with pump implementation and operation only, **3,201 and 2,632 acres** of agricultural lands would need to be reforested in the 2-year floodplain for spawning and rearing, respectively."[215] Alternative 3 would result in similar losses and mitigation needs.[216] However, the Compensatory Mitigation Appendix limits fisheries mitigation to a total of **3,201 acres without providing any explanation for this significant reduction.**[217] This is just 55% of the total amount of required mitigation acres acknowledged in the DEIS.

[214] The Corps intends to mitigate impacts to multiple resources "within a single footprint where possible" and will give preference to sites that "Provide opportunities to offset impacts to multiple affected natural resources and species." DEIS, Appendix J Compensatory Mitigation Plan at 12, 15.
[215] DEIS, Appendix J Compensatory Mitigation Plan at 12 (Table 3). The DEIS also hypothesizes—without any justification or documentation—that voluntary measures referenced in Alternative 3 would result in "overall benefits to aquatic resources and fisheries." DEIS, Main Report at 147. However, the reliance on voluntary measures to offset impacts is explicitly rejected in the Clean Water Act veto.
[216] DEIS, Main Report at 147 (Alternative 3 would result in an estimated loss of "2,184 and 1,748 HUs for spawning and rearing, equivalent to a reduction of 3,851 and 3,531 Average Daily Flooded Acres, respectively. To compensate for direct and indirect impacts associate with pump implementation and operation only, 3,088 and 2,470 acres of agricultural lands would need to be reforested in the 2-year floodplain for spawning and rearing, respectively.)
[217] DEIS, Appendix J Compensatory Mitigation Plan at 12 ("**Impacts to multiple resources will be mitigated within a single footprint where possible. For example mitigation for wetlands would also provide mitigation for waterfowl, aquatic resources, and terrestrial wildlife"*.).

As highlighted above, the Yazoo Backwater Area supports a highly productive floodplain fishery that includes at least 95 different species, if not more.[218] Of these, the U.S. Fish and Wildlife Service estimates that over 58 species depend on backwater flooding and access to the floodplain to fulfill numerous life history requirements.[219] And, of course, the Yazoo Pumps adverse impacts to fish and wildlife are the reason that EPA issued the 2008 Clean Water Act veto.[220]

Understanding the full extent of the Yazoo Pumps Alternatives on the overbank flooding regime is essential as highlighted in the 2008 Clean Water Act veto and the 2007 Fish and Wildlife Coordination Act Report. For example:

- "Much of the productive potential for fisheries in floodplain river ecosystems is determined by the dynamics of overbank flooding and riparian vegetation (Jackson and Ye 2000)."[221]

- "The presence of aquatic invertebrates in the relatively warmer backwater areas encourages spawning of fishes in the inundated floodplain, and the earlier that spawning can take place the longer the fish can remain on the floodplain and the higher the recruitment potential for the rivers' fish stocks (Jackson 2005)."[222]

- "In floodplain ecosystems such as the Yazoo Backwater Area (Figure 4), flooding not only enhances fish production, but also plays a key role in maintaining genetic and species diversity (Bayley 1995, Sparks 1995). Fishes use the floodplains for spawning, feeding, and refuge habitat (Welcomme 1979, 1985, Sparks et al. 1990). During flood periods, fishes gain access to inundated forests where they feed on terrestrial arthropods, fruits, seeds, flowers, and leaves (Ye 1996)."[223]

- "Welcomme (1976, 1985, 1986), Goulding (1980), and Sparks et al. (1990) indicate that fish production in floodplain rivers is strongly influenced by the timing, height, and duration of flooding. In the lower Mississippi River and its tributaries, positive relationships between fish abundance and the acreage of bottomland hardwood forests susceptible to flooding have been documented (Risotto and Turner 1985). Bayley (1995) found that multi-species fish biomass was significantly greater in rivers with flood pulses and floodplains than in impoundments with stable water levels."[224]

Despite the unquestionable importance of the Yazoo Backwater Area to fisheries resources and the critical need to fully assess impacts to these vital fisheries, the DEIS suffers from critical flaws that will understate fisheries impacts and render the fisheries assessment fundamentally unreliable. A number of these flaws are highlighted below.

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[218] 2008 Clean Water Act veto at 34.
[219] 2008 Clean Water Act veto at 34 (emphasis added).
[220] 2008 Clean Water Act veto at 70.
[221] 2008 Clean Water Act veto, Fisheries Technical Appendix at 16.
[222] 2008 Clean Water Act veto, Fisheries Technical Appendix at 15-16.
[223] 2007 Fish and Wildlife Coordination Act Report at 9.
[224] 2007 Fish and Wildlife Coordination Act Report at 9.

<u>First</u>, the Aquatic Resources and Fisheries appendix sates that the EnviroFish analysis only assessed impacts within the 2-year floodplain. However, failing to assess hydrologic changes and related impacts above the 2-year floodplain was explicitly rejected by the Clean Water Act veto.[225]

According to the Appendix, the EnviroFish analysis looked at the following area: "For this application, only agriculture and bottomland hardwood cover types within the 2- year flood frequency were considered. Fallow lands were not included in ADFA calculations because they represent less than 1% of all land-cover, but were used in calculation of reforestation mitigation acres during the growth transition period."[226] According to the Appendix, the Corps also "made certain assumptions on the application of EnviroFish to calculate ADFAs [Average Daily Flooded Acres]" including that "Flooded bottomland hardwoods in the 2-year flood frequency are the preferred spawning and rearing habitat."[227]

Since <u>all</u> spawning and rearing habitat above the 2-year floodplain will be lost through operation of the Yazoo Pumps Alternatives—because both will keep water from rising above the 2-year floodplain elevation throughout the spawning season—a failure to assess impacts above the 2-year floodplain would translate into a significant underestimate of fisheries impacts. In addition, in most situations fish spawning will not be restricted to the 2-year floodplain unless there are drastic habitat changes at higher elevations, a situation that does not exist in the Yazoo Backwater Area. In most cases, the habitat within the 2-year floodplain may be more preferred simply because it floods more often, and that flooding may occur at the exact optimal successional stage for fish. But it is highly unlikely that one could detect a statistical difference in fish preference/selection of the 2-yr floodplain versus the 5-yr floodplain.

The Conservation Organizations have been told that the Corps claims to have assessed impacts to the 5-year floodplain (though the Corps has not made this claim to the Conservation Organizations), but we are not able to confirm that based on the extremely limited information provided in the DEIS. We also highlight that if the restricted scope of the EnviroFish impacts analysis is an error in drafting, an error of this significance raises significant questions about the accuracy of the other information provided in the DEIS and must be corrected with a detailed explanation of how the modeling accounts for impacts beyond the 2-year floodplain.

<u>Second</u>, the EnviroFish model relied on an approach to assessing impacts to spawning habitat that was explicitly rejected by the Clean Water Act veto. The EnviroFish model restricted its assessment of spawning acres to those that had "a minimum depth of 1.0 foot and flooded for a minimum duration of 8 consecutive days."[228]

This approach was explicitly rejected by the Clean Water Act veto because it will result in a significant underestimate of impacts:

> The Corps stated that areas flooded one foot deep for eight days are sufficient for fish spawning. The Corps has stated that most fish species reach sexual maturity in one or two years, so a flood that occurs once every two years is necessary to maintain reproductive populations. **Eight days**

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[225] 2008 Clean Water Act veto and November 17, 2021 letter from EPA Assistant Administrator Radhika Fox to the Acting Assistant Secretary of the Army (Civil Works), Jamie Pinkham.
[226] DEIS, Appendix F-6 Aquatic Resources and Fisheries at 5.
[227] DEIS, Appendix F-6 Aquatic Resources and Fisheries at 6.
[228] DEIS, Appendix F-6 Aquatic Resources and Fisheries at 5.

> **is insufficient for any substrate spawning fish** (Schramm pers. comm. 2008). Eggs take 3 to 5 days to hatch. Larval fish fry are barely able to swim the first 7 to 10 days, while the yolk sac is being absorbed. If floodwaters are drawn down in 8 days, fry would be forced to retreat to deeper channels and lake habitats where mortality rates are high. Longer periods of shallow inundation in hardwood and other vegetated areas provide critical nursery habitat for growth and escape from predators.[229]
>
> These depth and timing requirements are critical. For example, "if the water recedes too rapidly off the floodplain, organic matter, nutrients, and newly hatched aquatic organisms may be carried into the river instead of remaining in the floodplain and permanent backwaters."[230] Many fish species also rely on the floodplain to provide rearing habitat.[231] For example, extended periods of shallow inundation in hardwood and other vegetated areas provide critical nursery habitat for growth and escape from predators. Accordingly, any reduction in extent or duration of inundation of flooded bottomland hardwood wetlands would reduce the fish productive capacity of the wetland.[232]

The "8 consecutive day" criterion relied upon by the Corps is at best, the amount of time needed for successful egg hatching. However, "8 consecutive days" may not even be sufficient for that, as egg development and hatching are always temperature-dependent (i.e., eggs will develop and hatch more quickly during warm temperatures and more slowly during cooler temperatures). As a result, while 8 days may be long enough for egg hatching in some (and perhaps most) years, it may not be long enough in all years.

Restricting the analysis of fisheries impacts to changes that might affect egg hatching (i.e., 8 consecutive days) also runs counter to the clear acknowledgement in the EnviroFish User Manual that the full range of early life history stages must be analyzed since they are "often the limiting factor in population growth" and "inter-annual variations in flooding regime of rivers [will] affect reproductive success and year-class strength of many species"[233]:

> The reproductive cycles of most floodplain fishes are closely related to timing, spatial extent, and duration of flooding. Numerous fish species undergo regular migrations to use inundated floodplains for a variety of reproductive purposes such as spawning, short-term incubation of eggs, and eventually as nursery habitat for yolk-sac (non-feeding) larvae (Guillory 1979, Ross and Baker 1983, Finger and Stewart 1987, Copp 1989, Scott and Nielson 1989). Once the yolk-sac is absorbed, larval fish must forage in the floodplain or adjacent waterbodies for small insects and zooplankton (Lietman et al. 1991). These early life history stages are often the limiting factor in population growth, **and inter-annual variations in flooding regime of rivers affect reproductive success and year-class strength of many species** (Starrett 1951, Guillory 1979, Larson et al. 1981; Zeug 2005).[234]

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[229] 2008 Clean Water Act veto, Fisheries Technical Appendix at 17.
[230] 2008 Clean Water Act veto at 56; *see also* DSEIS Appx. F-8 (Aquatic Resources) at 3.
[231] 2008 Clean Water Act veto at 34.
[232] 2008 Clean Water Act veto at 56.
[233] USACE, EnviroFish, Version 1.0: User's Manual, ERDC/EL TR-12-19, August 2012.
[234] Id. at 5 (emphasis added).

To properly assess impacts to fisheries resources, the Corps must at a minimum assess and account for the loss of 14 consecutive days of overbank flooding to a depth of at least one foot.

Third, the EnviroFish model masks the impacts of the Yazoo Pumps Alternatives by assessing and then averaging impacts across the full period of record—including during the many years when the Yazoo Pumps would not have been operating. This clearly understates the impacts of the Yazoo Pumps Alternatives, which will only operate when backwater flooding is predicted to exceed the 2-year floodplain elevation (90-feet).

According to the DEIS, the EnviroFish model summarized the average daily flood acres during period from March 1 through June 30 over a 43-year period of record (1978-2020).[235] However, as documented in the DEIS, the Yazoo Pumps Alternatives only would have operated during 22 of those years, or just 51% of those years.[236] The Yazoo Pumps Alternatives could only prevent overbank flooding—which could critically affect the ability of fish to spawn and rear in the floodplain—when the pumps operate; they obviously have no ability (or need) to do so when they will not be operated.

The DEIS should have assessed the loss of fisheries habitat both during peak flood years and during the years in the period of record when the Yazoo Pumps would have been operating. By including non-flood years—i.e., the years when the pumps would not be operating—in developing its summary of average daily flooded acres against which to assess impacts—the EnviroFish model masks the actual impacts of the Yazoo Pumps Alternatives and likely substantially understates the adverse impacts to fish spawning and rearing. For example, in 2000, the peak water elevation level at the landside Steele Bayou gage reached 77.4 feet.[237] In 2019, the peak water elevation level at this same gage reached 98.23 feet.[238] Relying on the average of these two years would suggest that average annual water elevations (and their related flooded acres) reach the 87.815-foot elevation. Under this scenario, the Yazoo Pumps Alternatives would **never** be turned on and as a result would have zero impacts on fisheries resources.

The EnviroFish model compounds this already problematic averaging by its double-averaging approach. The model first calculates the average daily flooded area for a given land use and a given year of water elevations and then averages the yearly average daily flooded acres for a given land use to obtain average daily flooded acres for the entire period of analysis.[239]

The biotic benefits of floodplain connectivity to fish species, including during infrequent but major flood events is well recognized. For example:

> Overall, we have demonstrated that inundation of the Mississippi River floodplain increased species diversity, relative abundance, and growth of some dominant fish species. Thus, these biotic benefits of floodplain connectivity are extremely important to riverine fishes. However, these areas are considered one of the most imperiled ecosystems in the world (Welcomme 1979; Nilsson et al. 2005), principally owed to human activities. Thus, conservation strategies or

[235] DEIS, Appendix F-6 Aquatic Resources and Fisheries at Table 1 (chart entitled "summary of Average Daily Flooded Acres for Each Reach by Land Cover, Alternative, and Life Stage During March-June based on the period of record from 1978 – 2020").
[236] DEIS, Appendix A Engineering Report at 135, Figure 2-112.
[237] USACE, RiverGages.com (http://rivergages.mvr.usace.army.mil).
[238] USACE, RiverGages.com (http://rivergages.mvr.usace.army.mil).
[239] USACE, EnviroFish, Version 1.0: User's Manual, ERDC/EL TR-12-19, August 2012 at 15.

> restoration approaches that attempt to reestablish connectivity are paramount to restoring large floodplain rivers and the associated biota worldwide. Because large floodplain rivers are prone to infrequent, major floods, restoration practitioners should anticipate such floods by creating large floodways that can be activated when necessary, thereby producing a win–win outcome of improving the ecological function of large, floodplain rivers while at the same time mitigating negative impacts of catastrophic floods on humans.[240]

However, the Yazoo Pumps Alternatives would significantly compromise this vital connectivity during periods that are particularly critical to riverine and floodplain fish species.

To properly understand the impacts of the Yazoo Pumps Alternatives on fisheries resources, it is essential that the DEIS analyze the habitat losses that would occur during periods of higher water elevations **when the pumps would be operating** and then assess the implications of those losses on spawning and rearing during that year along with the cascading impacts of losses of individual year classes to future fisheries health and productivity.[241] The DEIS does not provide this information, which is essential for making a reasoned choice among alternatives.

Fourth, the EnviroFish model restricted the maximum depth of rearing habitat "to 10 feet, due to low dissolved oxygen (DO) levels observed in deeper areas." This limitation, however, ignores the fact that low DO levels typically do not appear throughout the entire water column, but instead are typically seen in the lower elevations. If this EnviroFish restriction excluded all waters deeper than 10 feet as rearing habitat, it would have missed areas where rearing was still occurring in those areas above 10 feet where DO levels were not limited.

Fifth, the EnviroFish model lacks transparency (the entire discussion of the model covers just 9 pages), making it difficult to assess the full range of the potential problems with the model. Notably, neither the DEIS nor the EnviroFish User Manual provide any information or assessment related to the margins of error, confidence limits, or sensitivity analysis applicable to the DEIS EnviroFish estimates or to EnviroFish estimates more generally. Instead of providing actual information upon which to assess the relative accuracy of the EnviroFish analysis, the DEIS presents the EnviroFish numerical data in a manner that implies a level of precision that is not justified, leading to significant overconfidence in the accuracy of the EnviroFish data (often referred to as precision bias).

Notably, the DEIS does not provide the detailed information identified by EPA in 2020 as vital for understanding the EnviroFish model outputs. In its comments on the fundamentally flawed 2020 Draft EIS, EPA recommended among many other things that the:

> FSEIS and final 404(b)(1) Evaluation:
> - Provide a full description of the analysis of impacts on fish and other aquatic organisms and clarify how the values in the spawning and rearing habitat assessment were determined, including the methodology, assumptions, calculations, and uncertainties.
> - Identify where values changed between 2007 and 2020 analyses and clearly explain to what extent and why these changes are the result of the application of new

[240] Phelps, Q.E, Tripp, S.J, Herzog, D.P., Garvey, J.E., Temporary connectivity: the relative benefits of large river floodplain inundation in the lower Mississippi River, Restoration Ecology, January 2015, *Vol. 23, No. 1, pp. 53–56,* https://doi.org/10.1111/rec.12119. A copy of this study is provided at Attachment F to these comments.

[241] See studies provided at Attachment F to these comments.

data/analysis, changes in the assumptions or framework of the assessment, changes in conditions on the ground, and/or other factors.
- Clarify the assumptions and use of the weighting factor to reduce the loss of AAHUs in the 2020 spawning and rearing habitat impact analysis.[242]

Sixth, the DEIS significantly understates the amount of mitigation needed to offset fisheries impacts. Among many other reasons:

(a) The DEIS fails to assess the full array of adverse impacts to fisheries resources, including such things as the adverse impacts of intensified agricultural production, and the resulting increased use of nutrients and pesticides that ultimately will enter the rivers and streams adversely affecting water quality.

(b) Despite the many problems with the EnviroFish model discussed above, the DEIS relies solely on EnviroFish model outputs to identify needed mitigation. However, the model cannot provide a precise assessment of mitigation needs (at best it can provide a prediction of biological responses to different flooding scenarios).

(c) The Compensatory Mitigation Plan states that just 3,201 acres of reforestation of agricultural lands are required to mitigate fisheries impacts, even though the highly problematic EnviroFish model states that 5,833 acres of reforestation would be needed to offset direct and indirect impacts to spawning and rearing.[243] As a result, the Compensatory Mitigation Plan recommends implementing just 55% of the amount of mitigation required to offset direct and indirect impacts of the Yazoo Pumps Alternatives, presumably based on the Corps' stated goal of mitigating impacts to multiple resources "within a single footprint where possible."[244]

The DEIS provides no justification for this massive reduction in acreage. Moreover, the DEIS acknowledges that reforestation of agricultural lands has not been effective in offsetting fisheries impacts:

> Reforestation of agricultural lands has been the primary in-kind mitigation feature of the project area. However, despite over 30 years of reforesting lands in the project area, increases in fish diversity and/or richness has not been evident since monitoring began in the 1990's. Fish diversity metrics measured in the Big Sunflower-Steele Bayou drainage are typically 20-50% lower than reference watersheds in the same ecoregion.[245]

The Compensatory Mitigation Plan also provides no justification for being able to implement all mitigation within a single footprint – which the DEIS appears to believe can be done by reforesting 7,650 acres to address all project impacts, including to wetlands, fisheries, and

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[242] Enclosure to EPA Comments on the Draft Supplement No. 2 to the 1982 Yazoo Area Pumps Project Final Environmental Impact Statement, provided with EPA Comments on the Draft Supplemental Environmental Impact Statement on the Yazoo Area Pump Project (November 30, 2020).
[243] These numbers apply to Alternative 2.
[244] DEIS, Appendix J Compensatory Mitigation Plan at 12.
[245] DEIS, Appendix F-6 Aquatic Resources and Fisheries at 48.

waterfowl.[246] This would further dilute the amount mitigation being implemented to offset fisheries impacts.

As noted above, the proposed amount of mitigation to offset fisheries impacts is less than the amount of needed fisheries mitigation identified in the fundamentally flawed 2020 EIS, even though: (i) the level of fisheries impacts identified in the 2024 DEIS are significantly larger than those acknowledged in 2020; (ii) both assessments are based on the EnviroFish model; and (iii) both assessments applied the same 0.71 AAHU per acre mitigation credit for reforestation.[247]

Comparisons 2024 DEIS and 2020 FEIS Fisheries Impacts and Proposed Mitigation		
	2024 DEIS	**2020 FEIS**
Base Spawning (ADFA)	32,501	10,521
Lost Spawning (ADFA)	3,969	2,404
Spawning Mitigation—Reforestation Acres	**3,201**	**3,998**
Base Rearing (ADFA)	48,524	18,053
Lost Rearing (ADFA)	3,721	3,861
Rearing Mitigation—Reforestation Acres	**2,632**	**4,553**
Total EnviroFish Mitigation—Reforestation Acres	**5,833**	**8,551**

(d) Neither the proposed low flow wells nor operational changes to the Steele Bayou flood control structure offset fisheries impacts created by the Yazoo Pumps Alternatives. Both are designed to offset impacts from low flows, however, the Yazoo Pumps are intended to reduce high flows. Moreover, the relief wells will likely create their own set of adverse impacts and have not been demonstrated to work as claimed, as discussed in Section A and J of these comments.

Because of these many failings, the mitigation that has been proposed to offset fisheries impacts is not sufficient—even if the limited amount of mitigation proposed could somehow replace all lost functions and values critical to fisheries, which it cannot.

H. The DEIS Does Not Assess Impacts to Amphibians and Reptiles

The DEIS does not assess impacts to amphibians. The DEIS also does not assess impacts to 36 out of the 37 species of reptiles that rely on the Yazoo Backwater Area. This is an egregious failure that was highlighted as a fundamental problem in the Clean Water Act veto. The Conservation Organizations have repeatedly asked the Corps to fully assess the impacts to these vital species given the significance of the Yazoo Backwater Area wetlands and flood pulse for their survival, and the dire conditions facing these species worldwide.[248]

[246] DEIS, Appendix J Compensatory Mitigation Plan at 40.
[247] Information in this paragraph and the following chart was taken from: DEIS, Appendix F-6 Aquatic Resources and Fisheries and Appendix J Compensatory Mitigation Plan; Final Supplement No. 2 to the 1982 Yazoo Area Pump Project Final Environmental Impact Statement (December 2020), Appendix F-8 Aquatic Resources.
[248] Neither the 2007 nor 2020 studies of the Yazoo Pumps assessed impacts to amphibians and reptiles.

The 2008 Clean Water Act veto documents 21 species of amphibians and 37 species of reptiles in the Yazoo Backwater Area,[249] virtually all of which "benefit from the flood pulse."[250] The veto concludes that the Yazoo Pumps would adversely impact virtually all these species:

> "the proposed hydrologic alterations will adversely impact approximately 21 species of amphibians and 32 species of reptiles by disrupting their reproductive cycles and feeding opportunities and thereby reducing overall productivity."[251]

This is because:

> Reducing the spatial extent, depth, frequency, and duration of time wetlands in the project area are inundated will also adversely impact all 21 amphibian as well as 32 of the reptile species in the Yazoo River Basin that depend upon wetlands for breeding and foraging habitat. The life cycles of amphibians and reptiles in alluvial floodplain ecosystems are linked to hydrology as well as soil conditions and climate (Jones and Taylor, 2005). Abiotic factors that influence habitat conditions within floodplains include hydrologic regime, flood pulse intensity and duration, topography, wetland permanence (hydroperiod), water quality, and connectivity to rivers or streams. For many amphibians, the hydrology associated with floodplain wetlands is necessary for breeding and egg laying (Appendix 4).
>
> All the amphibian species listed as occurring in the Yazoo Backwater Area (Appendix 2) require wetlands and/or ephemeral pools for breeding (Jones and Taylor, 2005). The proposed project would reduce the amount of surface water that reaches these floodplain habitats making it difficult for portions of the amphibian population to survive (Semlitsch, 2005). For example, newts (*Notophthalmus viridescens*) require wetlands for breeding and egg deposition, while requiring vernal and ephemeral pools for adult life stages. The proposed project would also adversely affect reptile and amphibian species by reducing flood pulses and wetland water recharge, modifying river-wetland connectivity, and increasing habitat fragmentation. The reduction in flooding would also adversely affect the ability of amphibians to disperse to other suitable habitats (Jones and Taylor, 2005). Further, amphibians provide a valuable prey base for aquatic insects, fish, crayfish, birds, and mammals. Thus, a decline in amphibian and reptile populations will impact food resources for other animal groups.[252]

Amphibians thrive in cool wetland environments and small, isolated wetlands play especially important roles in amphibian productivity.[253] Amphibian populations thrive when there are a variety of small ecosystems within a regional landscape in which a "dynamic equilibrium" of different populations becomes established.[254] Habitat fragmentation can disturb this dynamic equilibrium by disruption patterns of amphibian emigration and immigration.

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[249] 2008 Clean Water Act veto at 32.
[250] 2008 Clean Water Act veto at 32-33.
[251] 2008 Clean Water Act veto at 60.
[252] 2008 Clean Water Act veto at 55.
[253] Gibbons, J. Whitfield, Christopher Winne, et. al. 2006. Remarkable Amphibian Biomass and Abundance in an Isolated Wetland: Implications for Wetland Conservation. Conservation Biology Volume 20, No. 5, 1457–1465.
[254] Mann, W., P. Dorn, and R. Brandl. 1991. Local distribution of amphibians: The importance of habitat fragmentation. Global Ecology and Biogeography Letters 1:36-41.

The 2008 Clean Water Act veto further highlighted that:

> **HEP does not evaluate the impacts of the proposed project on amphibians and reptiles.** The FSEIS's HEP assessments exclude entirely any assessment of the proposed project's adverse impacts on amphibians and reptiles. Species in both of these classes of animals depend upon wetland habitat to meet numerous life history requirements and would experience extensive adverse effects from the proposed project. . . . Shorter duration and less frequent flooding will significantly and adversely affect the vegetation and aquatic animal communities within these wetlands, nutrient and sediment cycling, and other functions that establish and maintain the diversity of habitats critical for fish and wildlife dependent upon them, including waterfowl, shorebird, and wading bird foraging habitats, fish spawning and rearing habitats, and amphibian, reptile, and mammal habitats. . . . These reductions and losses in wetland functions were not adequately factored into the FSEIS's HGM and HEP assessments.[255]

As a result, it is critical that the DEIS carefully assess the impacts to amphibians and reptiles from the Yazoo Pumps Alternatives and then evaluate the implications of those impacts in light of the many dire conditions and threats facing amphibian populations in the United States and worldwide and other critical cumulative impacts including climate change.

Amphibians

The most recent global assessment of amphibians, the second Global Amphibian Assessment, evaluated 8,011 species for the International Union for Conservation of Nature Red List of Threatened Species. Thes assessment found that:

> amphibians are the most threatened vertebrate class (40.7% of species are globally threatened). The updated Red List Index shows that the status of amphibians is deteriorating globally, particularly for salamanders and in the Neotropics. Disease and habitat loss drove 91% of status deteriorations between 1980 and 2004. Ongoing and projected climate change effects are now of increasing concern, driving 39% of status deteriorations since 2004, followed by habitat loss (37%).[256]

These finding indicate that "nearly 41 percent of amphibian species are threatened with extinction, making them the most imperiled class of vertebrates on the planet. Since 1980, at least 37 species have gone extinct, with disease and habitat loss being the primary culprits. The scientists warn climate change is quickly emerging as a major threat, attributing to 39 percent of populations declines since 2004.[257]

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[255] 2008 Clean Water Act veto, Appendix 6 Underestimation of Project Impacts and Overestimation of Project Benefits in the FSEIS for the Yazoo Backwater Area Project at 1-4.

[256] Luedtke, J.A., Chanson, J., Neam, K. *et al.* Ongoing declines for the world's amphibians in the face of emerging threats. *Nature* 622, 308–314 (2023). https://doi.org/10.1038/s41586-023-06578-4. A copy of this study is provided at Attachment G of these comments.

[257] Florida International University Press Release, Climate change emerges as major driver of amphibian declines, new research finds, October 4, 2023 (https://news.fiu.edu/2023/climate-change-emerges-as-major-driver-of-amphibian-declines-new-research-finds).

A 2013 study by the U.S. Geological Survey study[258] documents declines in amphibian populations in the United States. This study found that:

> overall occupancy by amphibians declined 3.7% annually from 2002 to 2011. Species that are Red-listed by the International Union for Conservation of Nature (IUCN) declined an average of 11.6% annually. All subsets of data examined had a declining trend including species in the IUCN Least Concern category. This analysis suggests that amphibian declines may be more widespread and severe than previously realized.[259]

The lead author of this study has highlighted that:

> Even though these declines seem small on the surface, they are not," said USGS ecologist Michael Adams, the lead author of the study. "Small numbers build up to dramatic declines with time. We knew there was a big problem with amphibians, but these numbers are both surprising and of significant concern.[260]

USGS also explained that:

> 1. USGS Amphibian Research and Monitoring Initiative (ARMI) has produced the first estimate of how fast we are losing amphibians from the places where they occur.
> 2. Even though the declines seem small on the surface, they are not. Small numbers build up to dramatic declines with time.
> 3. Even the species we thought were faring well – that is, fairly common and widespread – are declining, on average. Fowler's toads and spring peepers are examples of IUCN (International Union for Conservation of Nature) Least Concern Species for which we found a significant declining trend at the places we monitor.
> 4. We found a declining trend in every subset of data we examined including frogs versus salamanders, different regions of the United States, and protected areas like National Parks and National Wildlife Refuges.
> 5. We found evidence that amphibian declines are also taking place in protected areas like National Parks and National Wildlife Refuges.[261]

A 2007 study also highlighted the increasingly dire conditions of amphibians worldwide:

> Current extinction rates are most likely 136–2707 times greater than the background amphibian extinction rate. These are staggering rates of extinction that are difficult to explain via natural processes. No previous extinction event approaches the rate since 1980 (Benton and King, 1989).

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[258] Adams MJ, Miller DAW, Muths E, Corn PS, Grant EHC, et al. (2013) Trends in Amphibian Occupancy in the United States. PLOS ONE 8(5): e64347. https://doi.org/10.1371/journal.pone.0064347. A copy of this study is provided at Attachment G to these comments.
[259] USGS, https://www.usgs.gov/news/more-silent-springs-new-study-confirms-amphibian-decline-trends-us.
[260] https://www.usgs.gov/news/more-silent-springs-new-study-confirms-amphibian-decline-trends-us
[261] USGS,FAQs: Study Confirms U.S. Amphibian Populations Declining at Precipitous Rates (available at https://armi.usgs.gov/docs/Adams%20et%20al%202013%20PLoS%20Amphibian%20Decline%20USGS%20ARMI%20FAQ.pdf).

> Despite the catastrophic rates at which amphibians are currently going extinct, these are dwarfed by expectations for the next 50 yr (Fig. 1). If the figure provided by Stuart et al. (2004) is true (but see Pimenta et al., 2005; Stuart et al., 2005), one-third of the extant amphibians are in danger of extinction. This portends an extinction rate of 25,000–45,000 times the expected background rate. Episodes of this stature are unprecedented. Four previous mass extinctions could be tied to catastrophic events such as super volcanoes and extraterrestrial impacts that occur every 10 million to 100 million years (Wilson, 1992). The other mass extinction seems to be tied to continental drift of Pangea into polar regions leading to mass glaciation, reduced sea levels, and lower global temperatures (Wilson, 1992). The current event far exceeds these earlier extinction rates suggesting a global stressor(s), with possible human ties.[262]

Studies also point to the role of global climate change in promoting potentially catastrophic impacts to amphibian populations. For example:

- Global climate change will result in changes to weather and rainfall patterns that can have significant adverse effects on amphibians. Drought can lead to localized extirpation. Cold can induce winterkill in torpid amphibians. It is possible that the additional stress of climate change, on top of the stresses already created by severe loss of habitat and habitat fragmentation may jeopardize many amphibian species.[263]

- Recent studies suggest that climate change may be causing global mass extinctions of amphibian populations. Particularly alarming is the fact that many of these disappearances are occurring in relatively pristine area such as wilderness areas and national parks.[264] One recent study suggests that climate change has allowed the spread of a disease known as chytridiomycosis which has led to extinctions and declines in amphibians. Climate change has allowed this disease to spread by tempering the climate extremes that previously kept the disease in check.[265] About two-thirds of the 110 known harlequin frog species are believed to have vanished during the 1980s and 1990s because of the chytrid fungus *Batrachochytrium dendrobatidis.* Other studies indicate that amphibians may be particularly sensitive to changes in temperature, humidity, and air and water quality because they have permeable skins, biphasic life cycles, and unshelled eggs.[266]

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262 McCallum, M. L. (2007). "Amphibian Decline or Extinction? Current Declines Dwarf Background Extinction Rate. *Journal of Herpetology* 41 (3): 483–491. doi:10.1670/0022-1511(2007)41[483:ADOECD]2.0.CO;2.

263 Sjogren, P. 1993a. Metapopulation dynamics and extinction in pristine habitats: A demographic explanation. Abstracts, Second World Congress of Herpetology, Adelaide, Australia, p. 244; Sjogren, P. 1993b. Applying metapopulation theory to amphibian conservation. Abstracts, Second World Congress of Herpetology, Adelaide, Australia, p. 244-245.

264 Pounds, J. A., and M. L. Crump. 1994. Amphibian declines and climate disturbance: The case of the golden toad and the harlequin frog. Conservation Biology 8:72-85; Lips, K. R. 1998. Decline of a Tropical Montane Amphibian Fauna. Conservation Biology 12:106-117; Lips, K., F.Brem, R. Brenes, J.D. Reeve, R.A. Alford, J. Voyles, C. Carey, L. Livo, A. P. Pessier, and J.P. Collins 2006. Emerging infectious disease and the loss of biodiversity. Proceedings of the National Academy of Sciences 103:3165-3170.

265 Pounds, J.A., M.P.L. Fogden, J.H. Campbell. 2006. Biological response to climate change on a tropical mountain. Nature 398, 611-615.

266 Carey, C., and M. A. Alexander. 2003. Climate change and amphibian declines: is there a link? Diversity and Distributions 9:111-121.

- Climate change may also affect amphibian breeding patterns.[267] Amphibians spend a significant part of the year protecting themselves from cold or shielding themselves from heat. They receive cues to emerge from their shelters and to migrate to ponds or streams to breed from subtle increases in temperature or moisture. As the earth warms, one potential effect on amphibians is a trend towards early breeding, which makes them more vulnerable to snowmelt-induced floods and freezes common in early springs. Some studies already indicate a trend towards earlier breeding in certain amphibian species.[268]

- Increases in UV-B radiation in the northern hemisphere due to ozone depletion is also having an adverse impact on amphibians.[269] One study suggests that ultraviolet-B (UV-B) radiation adversely affects the hatching success of amphibian larvae.[270] High levels of UV-B also induced higher rates of developmental abnormalities and increased mortality in certain species (*Rana clamitans* and *R. sylvatica*) than others that were shielded from UV-B.[271] UV-B also can have detrimental effects on embryo growth.

Reptiles

The single reptile species considered in the DEIS is the Alligator Snapping Turtle,[272] which also must be assessed under the Endangered Species Act. The 36 other reptile species found in the Yazoo Backwater Area are not addressed. Each reptiles species, like all other types of species, will have unique needs that are not assessed in the evaluation of the Alligator Snapping Turtle.

The DEIS analysis of the Alligator Snapping Turtle does not appear to properly account for the significance of the Yazoo Backwater Area to this vulnerable, at-risk species. For example, as noted by several turtle biologists:

> Amongst the most unique wildlife inhabiting Lake George WMA and Panther Swamp NWR is the Western Alligator Snapping Turtle (AST) (*Macrochelys temminckii*), listed as Vulnerable in Mississippi and a candidate species for federal protection under the US Endangered Species Act. The population of Western Alligator Snapping Turtles within the above-mentioned locations is of paramount conservation value as population numbers of the species continue to decline range wide (Huntzinger et al. 2019; Lovich et al. 2018; Munscher et al. 2020). The AST population within Panther Swamp NWR, and the adjacent Lake George WMA, is among the largest and most demographically robust population in Mississippi (L. Pearson, pers. comm) and constitutes

[267] Carey, C., and M. A. Alexander. 2003. Climate change and amphibian declines: is there a link? Diversity and Distributions 9:111-121.
[268] Beebee, T. J. C. 1995. Amphibian Breeding and Climate. Nature 374:219-220; Blaustein, A. R., L. K. Belden, D. H. Olson, D. M. Green, T. L. Root, and J. M. Kiesecker. 2001. Amphibian breeding and climate change. Conservation Biology 15:1804-1809; Gibbs, J. P., and A. R. Breisch. 2001. Climate warming and calling phenology of frogs near Ithaca, New York, 1900-1999. Conservation Biology 15:1175-1178.
[269] Blither, M., and W. Ambach. 1990. Indication of increasing solar ultraviolet-B radiation flux in alpine regions. Science 248:206-208; Kerr, J. B., and C. T. McElroy. 1993. Evidence for large upward trends of ultraviolet-B radiation linked to ozone depletion. Science 262:1032-1034.
[270] Blaustein, A. R., P. D. Hoffman, D. G. Hokit, J. M. Kiesecker, S. C. Walls, and J. B. Hays. 1994a. UV repair and resistance to solar UV-B in amphibian eggs: A link to population declines? *Proceedings of the National Academy of Science* 91:1791-1795.
[271] Grant, K. P., and L. E. Licht. 1993. Effects of ultraviolet radiation on life history parameters of frogs from Ontario, Canada. Abstracts, Second World Congress of Herpetology, Adelaide, Australia, p. 101.
[272] DEIS, Appendix F-4 Terrestrial (Appendix F Alligator Snapping Turtle).

> a vital component of the Southern Mississippi – East Analysis Unit for the species. Furthermore, as of 2020, the Panther Swamp NWR population represents the only known refugia in Mississippi, and one of very few across the AST's geographic range, which has escaped the impacts of human harvest. This makes it among the least-impacted populations persisting today (Huntzinger et al. 2019; L. Pearson et al. 2019, pers. comm).[273]

As a result, impacts to this AST population, must be very carefully assessed, and accounted for in light of the cumulative threats to this species. As a fundamental part of this assessment, the DEIS must include a robust assessment of the impacts of the Yazoo Pumps Alternatives on the 8,000-acre Lake George WMA (which is mitigation land for wetland losses caused by previously constructed federal flood control projects) and on Panther Swamp National Wildlife Refuge. Both areas are supposed to be permanently protected from adverse impacts to their vital wetlands, but both will be impacted by the Yazoo Pumps Alternatives.

The importance of Panther Swamp, and the need to protect it are highlighted in the Clean Water Act veto, which among other things states that maintaining the bottomland forest system "in a diverse, healthy and productive condition is paramount to Panther Swamp NWR being able to fulfill the primary purpose of the refuge."[274] The Clean Water Act veto also highlights that studies and literature "strongly suggest" that "if periodic backwater flooding is further reduced or eliminated" in Panther Swamp, "the vegetative component of the BLH forest system will change over-time to a more drought tolerant / less flood tolerant species composition . . . ."[275]

Because the DEIS does not assess impacts to amphibians and does not assess impacts to 97% of the reptile species that rely on the Yazoo Backwater Area (and may not fully assess impacts to the one reptile species it does evaluate), the DEIS dramatically understates impacts to amphibians and reptiles.

I. The DEIS Does Not Assess Impacts to Listed Species or Critical Habitat

The DEIS does not assess impacts to multiple listed species or critical habitat, which is an egregious failing. Both the DEIS (and required Biological Opinion) must fully assess the impacts to species listed and their critical habitat under the Endangered Species Act to ensure that the Yazoo Pumps Alternatives will not jeopardize listed species or adversely modify critical habitat, as required by the ESA and Clean Water Act.[276]

The DEIS states that the Final EIS will assess the pondberry, pallid sturgeon, fat pocketbook mussel, and Northern Long-Eared Bat which are listed as endangered, and the Alligator Snapping turtle which is being considered for listing as a threatened species under the ESA.[277] However, the only analysis included in the DEIS is one for the Alligator Snapping turtle, and concerns with that analysis are discussed in Section H of these comments. The DEIS also must assess impacts to the many state listed

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[273] See letters from turtle biologists provided at Attachment H to these comments.
[274] 2008 Clean Water Act veto, Appendix 4 U.S. Fish and Wildlife Service Report on Effects of Yazoo Backwater Pumps Project on Flood Dependent Fauna of the Area at 27.
[275] Id. at 28.
[276] *See* 16 U.S.C. §1536(a)(2).
[277] DEIS, Main Report at 9. Other listed species are also found in the region, including the wood stork, sheepsnose mussel, and rabbitsfoot mussel. See, e.g., 2018. Mississippi Natural Heritage Program. Listed Species of Mississippi. (available at https://www.mdwfp.com/museum/seek-study/science-resources/endangered-species/ accessed November 29, 2020).

species found in the Yazoo Backwater Area, including the Louisiana black bear, swallow tailed kite, peregrine falcon, Bewicks wren, pyramid pigtoe, spike, and southern redbelly dace.

In its 2020 Yazoo Pumps FSEIS, the Corps claimed there was not enough data on the endangered pondberry to make an effects determination.[278] This omission foreclosed the public's ability to meaningfully comment on that DEIS and violated the Corps' obligation under the ESA to ensure the proposed plan would not jeopardize the species in violation of the ESA. Yet, the Corps commits the very same error in the DEIS, acknowledging that it once again has not provided any analysis of adverse impacts to pondberry. The Corps must reinitiate formal consultation with the Fish and Wildlife Service and comprehensively assesses the impacts of all alternatives on the survival and recovery of the species, as that is essential to make an informed decision.

Through that formal consultation, the Corps and the Fish and Wildlife Service must comprehensively analyze the impacts of the Preferred Alternative on the 5-year floodplain, which contains the majority of pondberry colonies in the Yazoo Backwater Area. As explained by the Fish and Wildlife Service, the pondberry is a wetland plant found in habitats that experience regular overbank flooding—such as many of the populations within bottomland hardwood forests of Mississippi.[279]

In the Yazoo Backwater Area, "most colonies/sites are located on the more frequently flooded 0-5 year floodplain," as shown by the Corps' data.[280] The Yazoo Pumps Alternatives would significantly alter the hydrology of these sites, as highlighted by EPA in the Clean Water Act veto, documented by the Fish and Wildlife Service in the 2007 Biological Opinion, and acknowledged in the DEIS itself. Accordingly, the Corps must consider: (1) the extent to which the Yazoo Pumps Alternatives would reduce flooding in relation to baseline conditions (which must be analyzed and updated, particularly for the pondberry as discussed below); (2) the change in hydrology due to a reduction in backwater flood frequency; (3) the extent that changes in backwater flooding by the project would alter the hydrology of known sites in the Yazoo Backwater Area, including the Delta National Forest; and (4) the response of the pondberry to these hydrological changes, among other things.

As part of this analysis, the Corps and the Fish and Wildlife Service must carefully identify the survival and recovery needs of the pondberry (*i.e.*, tipping points) to evaluate whether the species will be jeopardized. A tipping points analysis is critical because the Yazoo Pumps Alternatives would significantly alter the hydrology of the Yazoo Backwater Area, degrading some of the few known remaining populations in the species' range.[281] Accordingly, a tipping point analysis is essential to ensure that the Yazoo Pumps Alternatives do not push the species across the line to eventual extinction, or past a point from which recovery is impossible.

Through the consultation process, the Corps and the Fish and Wildlife Service also must consider significant new information regarding the pondberry's endangered status. In 2014, the Fish and Wildlife Service undertook a 5-year review and found that "some pondberry colonies have become extirpated on

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[278] 2020 FSEIS Appx. H (TES and MBTA) at 1.
[279] U.S. Fish and Wildlife Service Pondberry Final Biological Opinion (July 2, 2007) at 62 [hereinagter "BiOp"]; *see also* U.S. Fish and Wildlife Service, Southeast Region Mississippi Field Office, Pondberry, 5-Year Review: Summary and Evaluation (2014), available at https://ecos.fws.gov/docs/five_year_review/doc4358.pdf [hereinafter "5-Year Review"].
[280] 2007 Biological Opinion at 62.
[281] 2007 Biological Opinion at 117.

the [Delta National] Forest, while others have experienced recent declines, potentially related to stem dieback, hydrology, interspecific plant competition, and natural canopy disturbances."[282] The Fish and Wildlife Service's subsequent 5-year review (completed in 2021) identified a "rapid decline" in pondberry populations on the Delta National Forest.[283] The Corps must factor these recent declines into the baseline condition and evaluate the synergistic impacts of the Yazoo Pumps Alternatives on the species' survival and recovery.

Furthermore, the Corps and the Fish and Wildlife Service must fully evaluate the purported severe decline in wetland acreage in the 2-year floodplain. According to the 2020 FSEIS, there has been a 1 foot to 3 foot reduction in the 2-year floodplain elevation, which has resulted in the loss of at least 96,139 acres of wetlands in the 2-year floodplain in very short period of time. According to the Notice of Intent for this DEIS, the 2-year floodplain elevation is 1.7-feet-NGVD lower than provided in the 2007 EIS, and the 5-year floodplain elevation level is 2.6-feet-NGVD lower than provided in the 2007 FSEIS.[284] If these changes are indeed accurate, the Corps must assess how the lower floodplain elevations and related losses and modifications of wetland habitats have impacted pondberry colonies and the extent to which the Yazoo Pumps Alternatives could exacerbate the problem and jeopardize the species.[285] This is particularly necessary given the declines in pondberry populations over this same timeframe.

In addition, the Corps and the Fish and Wildlife Service must reevaluate the conservation measure proposed in the Biological Opinion. To avoid a jeopardy determination, the Corps had agreed to establish two new pondberry populations in areas where the hydrology would not be adversely affected.[286] As made clear in the Fish and Wildlife Service's 5-year review, however, attempts to transplant pondberry populations have been "met with limited success."[287]

> In Mississippi, experimental outplantings of naturally rooted pondberry stems were established at Leroy Percy State Park and Yazoo National Wildlife Refuge in Washington County as well as Hillside and Morgan Brake National Wildlife Refuges in Holmes County (Devall et al. 2004a). Survival one year after transplanting ranged from 35% to 84%. The current status of these transplants is unknown. In addition, plants cloned from populations in Sharkey and Bolivar Counties, Mississippi using micropropagation techniques (cf. Hawkins et al. 2007) were successfully transplanted to a research facility in Sharkey County (cf. Lockhart et al. 2006). This site is essentially a garden plot and well-maintained. It is unknown how these clones would perform in the wild.[288]

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[282] 5-Year Review at 14.
[283] U.S. Fish and Wildlife Service, Southeast Region Mississippi Field Office, Pondberry, 5-Year Review: Summary and Evaluation (2021) at 10, available at https://ecosphere-documents-production-public.s3.amazonaws.com/sams/public_docs/species_nonpublish/3612.pdf.
[284] Comparing elevations provided at 88 Fed. Reg. at 43103, with elevations provided at 2007 EIS, Appendix 6 at page 6-44.
[285] The 5-Year Review highlights how large flood control projects within the Mississippi Alluvial Valley have likely contributed to the decline of pondberry populations within bottomland hardwood forests of this area, particularly within the Big Sunflower River and Yazoo River drainages of Mississippi. 5-Year Review at 22. In the absence of such regular flood regimes, pondberry may be outcompeted by other vegetation. *Id.*
[286] 2007 Biological Opinion at 115.
[287] 5-Year Review at 20.
[288] 5-Year Review at 21.

This data undercuts the Corps' reliance on transplanting efforts to ensure against jeopardy to the species.

As part of the consultation process, the Corps and the Fish and Wildlife Service also must address the adverse impacts of the Yazoo Pumps Alternatives on other listed or threatened species in the Yazoo Backwater Area. This assessment must, among many other things be based on:

(1) An accurate assessment of the potential for the adverse impacts of the Yazoo Pumps Alternatives on the hydrology of the Yazoo Backwater Area, including the full array of impacts to wetland extent and function to wetlands (including short hydro-period wetlands) throughout the Yazoo Backwater Area. This assessment should not be artificially limited as was done in the 2007 and 2020 studies. That requires fixing the errors in the DEIS outlined above.

(2) The best available scientific data on the presence and needs of listed species. For example, the 2008 Clean Water Act veto unequivocally found that the pumps would "significantly degrade critical habitat for over 40 wetland dependent bird species," including the Wood Stork[289] and the Mississippi Natural Heritage Program identifies the Wood Stork as being in the region.[290] However, the Corps has chosen not to review the Wood Stork in this DEIS. the Mississippi Natural Heritage Program[291] and the DEIS[292] also note the endangered sheepsnose and rabbitsfoot mussels are found in the region but the Corps has chosen not to review impacts to these species in the DEIS. The Corps must consider all available data to ensure that it is reviewing all listed species that could be affected by the Yazoo Pumps Alternatives.

(3) A comprehensive assessment of how the elimination of critical spawning habitat, degradation of rearing habitat, and impairment of aquatic food webs will impact the host fishes for the threatened and endangered mussel species that likely inhabit the Yazoo Backwater Area. Floodplain fisheries are sustained by a network of riverine backwater wetlands[293] and the Yazoo Pumps Alternatives would significantly degrade this ecosystem. The Corps must consider how loss of spawning and rearing habitat will further impact mussel species.

J. The DEIS Does Not Assess Impacts to Water Quality Within the Yazoo Backwater Area

The DEIS does not assess impacts to water quality within the Yazoo Backwater Area. As a result, the DEIS does not look at such critical issues as the impacts on water quality from the degradation of 89,0000 to 93,000 acres of wetlands. The DEIS also does not assess the water quality impacts from the agricultural intensification that is a fundamental purpose of the projects. Agricultural intensification will result in even more fertilizer and pesticide applications and runoff into Yazoo Backwater Area waters.

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[289] Clean Water Act 404(c) Final Determination at 54.

[290] 2018. Mississippi Natural Heritage Program. Listed Species of Mississippi. (available at https://www.mdwfp.com/museum/seek-study/science-resources/endangered-species/ accessed November 29, 2020).

[291] Id.

[292] DEIS, Appendix F-6 Aquatic Resources and Fisheries at 47-48.

[293] Clean Water Act 404(c) Final Determination at 34.

The DEIS ignores these concerns and simply assumes that pollutant levels (such as for phosphorous and nitrogen) would remain the same in the Yazoo Backwater Area. As a result, the only water quality impacts the DEIS does look at are impacts outside the Yazoo Backwater Area that would result from the discharge of the Yazoo Pumps into the Yazoo River (i.e., downstream impacts to phosphorus and nitrogen concentrations).

The DEIS also fails to correct glaring deficiencies identified by the EPA regarding the discussion of dissolved oxygen levels. In 2020, the Corps suggested that a series of low flow wells would improve flow and water quality conditions in the backwater area. The EPA deemed the conclusory analysis insufficient and directed the Corps to provide information justifying its assertions.[294] The DEIS fails to do so, and instead repeats verbatim the conclusory analysis of dissolved oxygen that EPA deemed inadequate.[295]

To comply with the Clean Water Act, the DEIS must demonstrate that the Yazoo Pumps Alternatives will not cause or contribute to violations of any applicable state water quality standard. If the Yazoo Pumps Alternatives would do so, they are prohibited by the Clean Water Act 404(b)(1) Guidelines.[296] This prohibition is especially relevant as the Yazoo Backwater Area already suffers from degraded water quality due to pollutants such as sediment, pesticides, and excessive nutrients. As a result, the area includes an extensive list of section 303(d) impaired waters, some of which are subject to strict Total Maximum Daily Loads (TMDL). Furthermore, Mississippi's anti-degradation standards protect all the natural streams and wetlands in the area.[297]

The Yazoo Pumps Alternatives (and any derivation of the Yazoo Pumps) would exacerbate pollution levels in the Yazoo Backwater Area leading to exceedances of state water quality standards. Among other impacts, the proposed project would: (1) degrade 89,839 to more than 93,306 acres of wetlands that play a crucial role in protecting water quality; (2) increase agricultural production and the use of fertilizers and pesticides; and (3) possibly increase sedimentation in the Yazoo River. The net result could trigger exceedances of state water quality standards, and the Corps must provide "sufficient information" to conclude that this would not happen[298] before it could move forward with the project. But the DEIS fails to do so.

1. The DEIS Does Not Assess Impacts to State Water Quality Standards

The Yazoo Backwater Area contains a network of streams and channels that ultimately connect through the Yazoo River to the Mississippi River near Vicksburg. Most stream flow in the Yazoo River originates in the uplands along the eastern flank of the basin and is carried to the Yazoo River via the Coldwater, Yokona, Tallahatchie, and Yalobusha Rivers, and several smaller streams. Interior drainage is provided

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[294] EPA Comments on the Draft Supplement No. 2 to the 1982 Yazoo Area Pumps Project Final Environmental Impact Statement, Enclosure at 4 ("While the 2020 DSEIS includes qualitative statements indicating that the proposed wells will improve flow, water quality, and biological conditions, as discussed in the Mitigation section below, no data or quantitative estimates are included to support these statements.").

[295] *Compare* DEIS Appx. H ¶¶ 78-83 *with* 2020 FSEIS, Appx. I ¶¶ 80-85.

[296] *See* 40 C.F.R. § 230.10(b); *see also id.* § 131.21(d) (stating that state water quality standards must be used in "evaluating proposed discharges of dredged or fill material under section 404").

[297] 11 Code Miss. R. Pt. 6, R. 2.1.

[298] *See* 40 C.F.R. § 230.12(a)(3)(iv).

by numerous small streams that discharge to Deer Creek, the Big Sunflower River, or Bogue Phalia, which all flow to the lower Yazoo River.

Mississippi classifies all the natural streams and waters in the Yazoo Backwater Area as "Fish and Wildlife" waters, ensuring their protection under the state's anti-degradation policy.[299] Fish and Wildlife waters "are intended for fishing and for propagation of fish, aquatic life, and wildlife. Waters that meet the Fish and Wildlife Criteria shall also be suitable for secondary contact recreation. Secondary contact recreation is defined as incidental contact with the water during activities such as wading, fishing, and boating, that are not likely to result in full body immersion."[300] Mississippi's anti-degradation policy states that "[i]n no event . . . may degradation of water quality interfere with or become injurious to existing instream water uses."[301]

However, these vital waters in the Yazoo Backwater Area suffer from degraded water quality due to the impacts of agricultural past practices prevalent in the Mississippi Delta. In 2005, the state reported that overall water quality was **lower in this area than anywhere else in the state**, as evidenced by a region-wide advisory regarding fish consumption, including numerous consumption bans in some area waters because of high pesticide levels. EPA also documented the extensive list of 303(d)-impaired water bodies in the area in 2007 due to pollutants such as sediment, pesticides, and excessive nutrients.[302] As a result, numerous waterbodies are subject to TMDLs with little or no margin for additional pollution.

The Corps acknowledged in the 2007 FSEIS its obligation to analyze the TMDL and Section 303(d) list waters "because Mississippi's most recent edition of its water quality criteria states that these waters shall not be further impaired for any designated use."[303] Since then, the Mississippi Department of Environmental Quality (MDEQ) has completed numerous additional TMDLs for streams and rivers in the Yazoo Backwater Area, including at least the following TMDLs:

(1) Organic Enrichment / Low Dissolved Oxygen (DO) for Swiftwater Bayou Watershed (February 2014)

(2) Total Nitrogen and Total Phosphorus for Silver Creek (June 2008)

(3) Total Nitrogen and Total Phosphorus for Jaynes Bayou (June 2008)

(4) Total Nitrogen and Total Phosphorus for Lake Jackson (June 2008)

(5) Total Nitrogen and Total Phosphorus for Cypress Lake (June 2008)

(6) Total Nitrogen and Total Phosphorus for Selected Large Rivers in the Delta (June 2008)

(7) Yazoo River Basin Designated Oxbow Lakes for Sediment (April 2008)

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[299] *See* https://www.mdeq.ms.gov/wp-content/uploads/2007/10/yzmap&tablewqsadptaug07.pdf (Map depicting Yazoo River Basin Water Quality Standards).
[300] 11 Code Miss. R. Pt. 6, R. 2.3.
[301] 11 Code Miss. R. Pt. 6, R. 2.1.
[302] *See* 2008 Clean Water Act Final Determination, Appendix 7.
[303] 2007 EIS, Appx. 16 ¶235.

(8) Total Nitrogen, Total Phosphorus, and Organic Enrichment / Low Dissolved Oxygen for the False River (April 2008)

(9) Yazoo River Basin Delta Region for Impairment Due to Sediment (April 2008)

(10) Total Nitrogen, Total Phosphorus, and Organic Enrichment / Low Dissolved Oxygen for Deer Creek (June 2008)

(11) Total Nitrogen, Total Phosphorus, and Organic Enrichment / Low Dissolved Oxygen for Snake Creek (June 2008)

(12) Total Nitrogen, Total Phosphorus, and Organic Enrichment / Low Dissolved Oxygen for Collins Creek (June 2008)

The DEIS must—but does not—evaluate whether the Yazoo Pumps Alternatives comply with state water quality standards, including these TMDLs.[304]

2. The DEIS Does Not Assess Water Quality Impacts from Wetland Degradation

Wetlands perform a series of critical functions that reduce excessive levels of pollutants. As documented by EPA,

> wetlands permanently remove or temporarily immobilize elements and compounds that are imported to the wetland from various sources, but primarily via the flood cycle. Elements include macronutrients essential to plant growth (e.g., nitrogen, phosphorus, and potassium) as well as heavy metals (zinc, chromium, etc.) that can be toxic at high concentrations. Compounds include pesticides and other imported materials. The primary benefit of this function is that the removal and sequestration of elements and compounds by wetlands reduces the load of nutrients, heavy metals, pesticides, and other pollutants in rivers and streams.[305]

Despite this critical pollutant-filtering role, the DEIS does not assess whether the impacts from the degradation of 89,839 to more than 93,306 acres of wetlands would contribute to violations of state water quality standards. As documented in the 2008 Clean Water Act veto, "the extensive loss of pollutant filtering and removal functions by wetlands impacted by the proposed project could exacerbate the elevated concentrations of the pollutants of concern, potentially causing or contributing to violations of applicable state water quality standards (40 CFR 230.10(b)).[306]

The DEIS must assess whether and how the extensive loss of wetland functions from the Yazoo Pumps Alternatives could exacerbate water quality degradation within the Yazoo Backwater Area and trigger violations of existing water quality standards.

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[304] *See* 40 C.F.R. § 1502.9(c)(1).
[305] 2008 Clean Water Act veto at 30.
[306] 2008 Clean Water Act veto at 52.

3. The DEIS Does Not Assess Water Quality Impacts from Agricultural Intensification

A fundamental purpose of the Yazoo Pumps Alternatives is to facilitate agricultural intensification which almost certainly will result in increased use of fertilizers and pesticides, and will likely also result in increased irrigation. The net result would be unavoidable degradation of water quality, as made clear by Dr. R. Eugene Turner, one of the nation's preeminent wetland scientists. In his comments on the 2008 Clean Water Act veto, Dr. Turner clearly explained the consequences for water quality:

> When drained there will be substantial changes to the soils which will encourage agricultural development and this development will use fertilizers. The fertilizers will leak from the system sooner or later. Water quality compromises are, therefore, unavoidable. Several studies, for example, have demonstrated a positive linear relationships between soil P and P in runoff (Sharpley 1995; Pote et al. 1996; Davis et al. 2005).
>
> The net result is a loss in nutrient uptake/transformation, and an increase in the nutrient loading from agricultural uses of fertilizer and the 'mining' of nutrients stored in vegetation and soils (Turner and Rabalais 2003).[307]

The Corps must analyze whether the "net result" of the proposed alternatives—the loss of wetland capacity coupled with increased agricultural production—would impermissibly degrade waterways in the Yazoo Backwater Area or exceed TMDLs. For example, in 2006, MDEQ listed numerous rivers in the Yazoo Backwater Area as impaired for nutrients (total phosphorous and nitrogen), including Steele Bayou and the Yazoo River.[308] Though the TMDL only set limits for point-sources, it acknowledged the need to assess whether these standards were sufficient, given nutrient loadings from the non-point sources, including agricultural cropland.[309] Indeed, the DEIS readily acknowledges the significant increase in nutrient loading due to the shift of agricultural production and resultant increased use of fertilizers. Given the impairment of waterways due to nutrients, the Corps must demonstrate the proposed project would not cause exceedances of existing TMDLs or otherwise degrade water quality and impair existing uses in the backwater area.

The Corps also has an obligation to analyze impacts of increased nutrient loadings on downstream waters, including the Gulf of Mexico.[310] Each summer, an extensive area of hypoxia forms in the Gulf of Mexico as a result of high nutrients in the Mississippi and Atchafalaya Rivers. The Yazoo River basin is a significant cause of the problem due to its proximity to the Gulf and intensive agricultural operations.[311] The proposed project would exacerbate this problem, requiring that the DEIS thoroughly assess these

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307 Comments of Dr. R. Eugene Turner submitted to the EPA docket on the Yazoo Pumps veto on April 23, 2008. Full citations to the studies referred to in this quotation are included in Dr. Turner's comments.

308 *See* TMDL Total Nitrogen and Total Phosphorus For Selected Large Rivers in the Delta (June 2008), at 4 (available at https://www.mdeq.ms.gov/wp-content/uploads/TMDLs/Yazoo/Delta_Large_Rivers_FINAL_Nutrients_TMDL_35411.pdf).

309 *Id.* at 22.

310 *See Riverside Irrigation District v. Andrews*, 758 F.2d 508, 511–12 (10th Cir. 1985) (requiring Corps to analyze the secondary effects of a proposed project on downstream waters).

311 In 1996, the Yazoo River Basin alone contributed at least 5.7% of phosphorous loads, 2.7% of nitrogen loads, and 1% of the nitrogen load in the Gulf. *See* Coupe, R.H., Concentrations and Loads of Nitrogen and Phosphorous in the Yazoo River, Northwestern Mississippi, 1996-97 (available at); *see also* F. Douglas Shields Jr., et al., Nitrogen and Phosphorous Levels in the Yazoo River Basin, Mississippi, Ecohydrology (2009) (available at https://naldc.nal.usda.gov/download/44722/PDF).

potential impacts to ensure that they will not cause or contribute to water quality violations downstream.

The DEIS does not examine whether or how the Yazoo Pumps Alternatives would increase the total load of nitrogen in the Yazoo Backwater Area, which is subsequently discharged by the pumps into the Yazoo River (and from there to the Mississippi River). Instead, the DEIS falsely assumes that the "overall mass loading [of Nitrogen] to the Mississippi River . . . should remain approximately the same."[312] But that is contradicted by the very purpose of the project. As a result, the DEIS fails to include the requisite analysis of increased loadings on water quality.

The DEIS also does not examine the risks of increased irrigation because of the agricultural intensification induced by the Yazoo Pumps Alternatives. As the DEIS acknowledges, irrigation in the Yazoo Backwater Area is already contributing to extreme low flow conditions that could be greatly exacerbated by the agricultural intensification that is the primary purpose of the Yazoo Pumps Alternatives. This could have cascading adverse impacts on fish and wildlife as well. For example, agricultural irrigation already poses threats to the Yazoo Backwater Area particularly drought years, and drought has been cited as the greatest threat to the survival of the at least 33 species of mussels found in the Big Sunflower River.[313] In years of worst drought conditions, mussel survey teams have found sections of rivers completely dewatered and disconnected with mussel beds fully exposed and all dead. Before drying takes place, rivers can separate into individual pools. With cessation of flow and a change from lotic to lentic conditions, high water temperatures in separated stream sections create low dissolved oxygen conditions that can kill mussels well before full drying takes place. These mass mussel die-offs in dry years, coupled with low recruitment of juvenile mussels in rivers impacted by various anthropogenic stresses makes it difficult for rare species to persist. One Big Sunflower gravel bed fully exposed in a drought can result in total mortality of a small, isolated population.

K. The DEIS Does Not Assess Cumulative Impacts

The DEIS does not assess cumulative impacts, which is a fundamental failing as the cumulative impacts analysis is a critical component of NEPA review. The cumulative impact analysis ensures that the reviewing agency will not "treat the identified environmental concern in a vacuum."[314]

Cumulative effects are defined as:

> "effects on the environment that result from the incremental effects of the action when added to the effects of other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative effects can result from individually minor but collectively significant actions taking place over a period of time."[315]

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[312] DEIS, Appendix H Water Quality at 54.

[313] Surveys conducted in 2023 by a team of biologists from state and federal wildlife agencies documented 33 species of freshwater mussels in the Big Sunflower River, including two species protected by the Endangered Species Act—the Sheepnose mussel and Rabbitsfoot mussel, and two species considered "state rare" and on the watch list of the Mississippi Natural Heritage program—Spike and Round pigtoe. Survey information is available from the Mississippi Museum of Natural Science.

[314] *Grand Canyon Trust v. FAA*, 290 F.3d 339, 346 (D.C. Cir. 2002).

[315] 40 C.F.R. § 1508.1(g)(3).

The cumulative impacts analysis must examine the cumulative effects of federal, state, and private projects and actions.[316] The cumulative impacts analysis must also evaluate the cumulative impacts of climate change.[317]

Importantly, as the Council on Environmental Quality has made clear, in situations like those in the Yazoo Backwater Area where the environment has already been greatly modified by human activities, it is **not** sufficient to compare the impacts of the proposed alternative against the current conditions. Instead, the baseline must include a clear description of how the health of the resource has changed over time to determine whether additional stresses will push it over the edge.[318]

In evaluating cumulative impacts:

> "The analyst's primary goal is to determine the magnitude and significance of the environmental consequences of the proposed action in the context of the cumulative effects of other past, present, and future actions. Much of the environment has been greatly modified by human activities, and most resources, ecosystems, and human communities are in the process of change as a result of cumulative effects. **The analyst must determine the realistic potential for the resource to sustain itself in the future and whether the proposed action will affect this potential; therefore, the baseline condition of the resource of concern should include a description of how conditions have changed over time and how they are likely to change in the future without the proposed action.** The potential for a resource, ecosystem, and human community to sustain its structure and function depends on its resistance to stress and its ability to recover (i.e., its resilience). Determining whether the condition of the resource is within the range of natural variability or is vulnerable to rapid degradation is frequently problematic. Ideally, the analyst can identify a threshold beyond which change in the resource condition is detrimental. More often, the analyst must review the history of that resource and evaluate whether past degradation may place it near such a threshold. For example, the loss of 50% of historical wetlands within a watershed may indicate that further losses would significantly affect the capacity of the watershed to withstand floods. **It is often the case that when a large proportion of a resource is lost, the system nears collapse as the surviving portion is pressed into service to perform more functions.**"[319]

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[316] The requirement to assess non-Federal actions is not "impossible to implement, unreasonable or oppressive: one does not need control over private land to be able to assess the impact that activities on private land may have" on the project area. Resources Ltd., Inc. v. Robertson, 35 F.3d 1300, 1306 (9th Cir. 1993).
[317] *See* Center for Biological Diversity v. Nat'l Hwy Traffic Safety Administration, 538 F.3d 1172, 1217 (9th Cir. 2008) (holding that analyzing the impacts of climate change is "precisely the kind of cumulative impacts analysis that NEPA requires agencies to conduct" and that NEPA requires analysis of the cumulative impact of greenhouse gas emissions when deciding not to set certain CAFE standards); Center for Biological Diversity v. Kempthorne, 588 F.3d 701, 711 (9th Cir. 2009) (NEPA analysis properly included analysis of the effects of climate change on polar bears, including "increased use of coastal environments, increased bear/human encounters, changes in polar bear body condition, decline in cub survival, and increased potential for stress and mortality, and energetic needs in hunting for seals, as well as traveling and swimming to denning sites and feeding areas.").
[318] Council on Environmental Quality, Considering Cumulative Effects Under the National Environmental Policy Act at 41 (January 1997).
[319] Council on Environmental Quality, *Considering Cumulative Effects Under the National Environmental Policy Act* (January 1997) at 41 (emphasis added).

A meaningful assessment of cumulative impacts must identify:

> "(1) the area in which effects of the proposed project will be felt; (2) the impacts that are expected in that area from the proposed project; (3) other actions – past, present, and proposed, and reasonably foreseeable – that have had or are expected to have impacts in the same area; (4) the impacts or expected impacts from these other actions; and (5) the overall impact that can be expected if the individual impacts are allowed to accumulate."[320]

In conducting the cumulative impacts assessment, it is not enough to simply catalog past, present, and reasonably foreseeable future actions. An EIS instead must determine the specific impacts on the system of those actions and determine whether those impacts combined with the proposed action would significantly affect the ecological health and functioning of the area impacted by the project.

As recognized by the 2008 Clean Water Act Final Determination, the adverse impacts of the Yazoo Pumps must be considered:

> in the context of the significant cumulative losses across the Lower Mississippi River Alluvial Valley (LMRAV), which has already lost over 80 percent of its bottomland forested wetlands, and specifically in the Mississippi Delta where the proposed project would significantly degrade important bottomland forested wetlands.[321]

The majority of those losses have been traced directly to the effects of federal flood control and drainage projects.[322] From just the 1970s to 2006, the Yazoo Backwater Area lost 11 percent of its remaining forested wetlands.[323] The loss and/or degradation of many tens of thousands of additional acres of wetlands from the Yazoo Pumps Alternatives would have catastrophic implications for the ecology of the Lower Mississippi Alluvial Valley and for the fish and wildlife that rely on those resources. For some species, the Yazoo Pumps Alternatives could be the proverbial straw that breaks the camel's back pushing species to or past their tipping points.

The DEIS also must comprehensively evaluate and account for the impacts to wetlands resulting from the highly significant reductions in flood stages in the project area. As discussed earlier in these comments, according to the 2020 FSEIS, there has been a 1 foot to 3 foot reduction in the 2-year floodplain elevation, which has resulted in the loss of at least 96,139 acres of wetlands in the 2-year floodplain in very short period of time. According to the 2020 Yazoo Pumps FSEIS, at least some of these significant reductions are the result of completion of the Holly Bluff Cut-off in 1958 and the Yazoo Backwater Levee in 1978:

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[320] TOMAC, Taxpayers of Michigan Against Casinos v. Norton, 435 F.3d 852 (D.C. Cir. 2006) (quoting Grand Canyon Trust, 290 F.3d at 345); Fritiofson v. Alexander, 772 F.2d 1225, 1245 (5th Cir. 1985) (holding this level of detail necessary even at the less detailed review stage of an Environmental Assessment).
[321] 2008 Clean Water Act Final Determination at iii.
[322] Department of the Interior, The Impact of Federal Programs on Wetlands, Volume I: The Lower Mississippi Alluvial Plain and the Prairie Pothole Region, A Report to Congress by the Secretary of the Interior, October 1988 at 60.
[323] Dahl, T.E., J. Swords and M. T. Bergeson. 2009. Wetland inventory of the Yazoo Backwater Area, Mississippi - Wetland status and potential changes based on an updated inventory using remotely sensed imagery. U.S. Fish and Wildlife Service, Division of Habitat and Resource Conservation, Washington, D.C. 30 p. (available at https://www.fws.gov/wetlands/documents/Wetland-Inventory-of-the-Yazoo-Backwater-Area-Mississippi.pdf).

> The median ≥5.0% flood duration elevation threshold was lowered approximately one to three feet as a result of implementation of the flood risk reduction features, translating to a large aerial decrease in potential wetland areas when superimposed on the Yazoo Study Area.[324]

The Notice of Intent for this DEIS states that the 2-year floodplain elevation is 1.7-feet-NGVD lower than provided in the 2007 EIS, and the 5-year floodplain elevation level is 2.6-feet-NGVD lower than provided in the 2007 FSEIS.[325]

The DEIS must fully evaluate the implications of these significant wetland losses throughout the Yazoo Backwater Area, the Mississippi Delta and the Mississippi River Alluvial Valley and the significant reductions if flood frequency elevations in the Yazoo Backwater Area. Notably, the EIS also must explain why, in the face of these significant changes in flood elevation, the authorized level of flood protection (as set forth in the 1941 project authorization) has not already been achieved. Additional information on this important issue is provided in Section S of these comments.

The DEIS must then evaluate how these cumulative losses and alterations affect the wildlife species that rely on the Yazoo Backwater Area's wetlands and the Mississippi Delta and Mississippi River Alluvial Valley. The wildlife impacts must themselves be assessed in light of the significant losses of wildlife throughout these regions and beyond.

A recent article in Science Magazine reported on the staggering loss of **three billion** north American birds since 1970:

> North America's birds are disappearing from the skies at a rate that's shocking even to ornithologists. Since the 1970s, the continent has lost 3 billion birds, nearly 30% of the total, and even common birds such as sparrows and blackbirds are in decline, U.S. and Canadian researchers report this week online in *Science*. "It's staggering," says first author Ken Rosenberg, a conservation scientist at the Cornell University Laboratory of Ornithology. The findings raise fears that some familiar species could go the way of the passenger pigeon, a species once so abundant that its extinction in the early 1900s seemed unthinkable.
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> The results, from the most comprehensive inventory ever done of North American birds, point to ecosystems in disarray because of habitat loss and other factors that have yet to be pinned down, researchers say.[326]

The EIS also must analyze the impacts of climate change in the cumulative impacts analysis. Indeed, analyzing the impacts of climate change is "precisely the kind of cumulative impacts analysis that NEPA requires agencies to conduct."[327]

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[324] 2020 FSEIS, Appendix F-5 (Wetlands) at 35-36.

[325] Comparing elevations provided at 88 Fed. Reg. at 43103, with elevations provided at 2007 EIS, Appendix 6 at page 6-44.

[326] Elizabeth Pennisi, Three billion North American birds have vanished since 1970, surveys show, Science, September 19, 2019 (available at https://www.sciencemag.org/news/2019/09/three-billion-north-american-birds-have-vanished-1970-surveys-show).

[327] Center for Biological Diversity v. Nat'l Hwy Traffic Safety Administration, 538 F.3d 1172, 1217 (9th Cir. 2008); Center for Biological Diversity v. Kempthorne, 588 F.3d 701, 711 (9th Cir. 2009) (NEPA analysis properly included analysis of the effects of climate change on polar bears, including "increased use of coastal environments, increased bear/human encounters, changes in polar bear body condition, decline in cub survival, and increased

Climate change is already causing significant impacts in the Mississippi River Valley and these impacts will likely grow, as recognized by the recently released Fourth National Climate Assessment.[328] The impacts of climate change are particularly significant for migratory species. As recognized by the United Nations Environment Program and the Convention on the Conservation of Migratory Species of Wild Animals, migratory wildlife is particularly vulnerable to the impacts of climate change:

> As a group, migratory wildlife appears to be particularly vulnerable to the impacts of Climate Change because it uses multiple habitats and sites and use a wide range of resources at different points of their migratory cycle. They are also subject to a wide range of physical conditions and often rely on predictable weather patterns, such as winds and ocean currents, which might change under the influence of Climate Change. Finally, they face a wide range of biological influences, such as predators, competitors and diseases that could be affected by Climate Change. While some of this is also true for more sedentary species, migrants have the potential to be affected by Climate Change not only on their breeding and non-breeding grounds but also while on migration.
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> Apart from such direct impacts, factors that affect the migratory journey itself may affect other parts of a species' life cycle. Changes in the timing of migration may affect breeding or hibernation, for example if a species has to take longer than normal on migration, due to changes in conditions *en route*, then it may arrive late, obtain poorer quality breeding resources (such as territory) and be less productive as a result. If migration consumes more resources than normal, then individuals may have fewer resources to put into breeding . . . .
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> * * *
>
> Key factors that are likely to affect all species, regardless of migratory tendency, are changes in prey distributions and changes or loss of habitat. Changes in prey may occur in terms of their distributions or in timing. The latter may occur though differential changes in developmental rates and can lead to a mismatch in timing between predators and prey ("phenological disjunction"). Changes in habitat quality (leading ultimately to habitat loss) may be important for migratory species that need a coherent network of sites to facilitate their migratory journeys. Habitat quality is especially important on staging or stop-over sites, as individuals need to consume large amounts of resource rapidly to continue their onward journey. Such high quality sites may [be] crucial to allow migrants to cross large ecological barriers, such as oceans or deserts.[329]

potential for stress and mortality, and energetic needs in hunting for seals, as well as traveling and swimming to denning sites and feeding areas.").

[328] The EIS should fully consider and carefully evaluate the information contained in the Fourth National Climate Assessment, which can be accessed at https://nca2018.globalchange.gov/.

[329] UNEP/CMS Secretariat, Bonn, Germany, *Migratory Species and Climate Change: Impacts of a Changing Environment on Wild Animals* (2006) at 40-41 (available at http://www.cms.int/publications/pdf/CMS_CimateChange.pdf).

Migratory birds are at particular risk from climate change. Migratory birds are affected by changes in water regime, mismatches with food supply, sea level rise, and habitat shifts, changes in prey range, and increased storm frequency.[330]

The DEIS must also carefully assess the cumulative impact on the loss of Yazoo Backwater Area wetlands in the context of the dire conditions currently facing amphibian populations worldwide and in the United States. Like migratory species, amphibians are at great risk from climate change. See discussion in Section H of these comments.

Cumulative impacts must be fully assessed and fully accounted for in the DEIS.

L. The DEIS Drastically Understates the Amount of Mitigation Needed and Violates Multiple Mitigation Mandates

The DEIS drastically understates the amount of mitigation that would be required to attempt to offset the unacceptable "damages to ecological resources, including terrestrial and aquatic resources, and fish and wildlife losses"[331] from the Yazoo Pumps Alternatives. The DEIS does not propose enough mitigation to offset the adverse impacts it has identified as required by 33 U.S.C. § 2283(d). The compensatory mitigation plan provided with the DEIS does not satisfy the requirements established by 33 U.S.C. § 2283(d). And the DEIS does not analyze mitigation measures with "sufficient detail to ensure that environmental consequences have been fairly evaluated"[332] as required by NEPA.

The Conservation Organizations do not believe it is possible to mitigate the adverse impacts to the full suite of ecological resources and fish and wildlife that would be harmed by the Yazoo Pumps Alternatives or any other derivation of the Yazoo Pumps. This assessment is borne out by decades of experience, and repeated confirmations by EPA—including in the 2008 Clean Water Act veto, and the scientific community.

The 2008 Clean Water Act veto explicitly determined that the Yazoo Pumps' significant adverse impacts could not be adequately mitigated by the Corps' proposal which was inconsistent with the requirements of the Clean Water Act.[333]

The Corps' continued inability to meaningfully mitigate the impacts of the Yazoo Pumps Alternatives is exemplified by its shockingly low mitigation proposal. The Corps contends (in Mitigation Alternative 4) that just "7,650 acres of wetlands are estimated to be needed for compensatory mitigation for the project" because "[w]etlands have the highest mitigation need and meeting the acres needed for wetland compensation will mitigation for the other resources (Table 3)."[334]

The Conservation Organizations are at a loss to understand how this extremely minimal amount of mitigation on lands whose hydrology would also be adversely affected could conceivably offset the degradation of 89,839 to more than 93,306 acres of hemispherically significant wetlands, let alone the

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[330] *Id*. at 42-43.
[331] 33 U.S.C. § 2283(d).
[332] Robertson v. Methow Valley Citizens Council, 490 U.S. 332, 352 (1989).
[333] 2008 Clean Water Act Final Determination at iii, 60-62. We also note that the Corps' 2007 FSEIS states that the agency still had not carried out mitigation for project site construction completed in 1987.
[334] DEIS, Appendix J Compensatory Mitigation Plat at 31 and 40.

highly significant cascading impacts to the vast array of fish and wildlife species that rely on those vital wetlands. We also note that the Corps' statement that just 7,650 acres of mitigation is required contradicts the DEIS statement that 12,583 acres of mitigation is required[335]—an amount that also is far too low to be able to offset impacts.

The Corps' inability to meaningfully mitigate the impacts of this project is further confirmed by the Corps' failure to mitigate for the significant and longstanding adverse impacts resulting from construction at the Yazoo Pumps site completed in 1987 and from multiple other projects in the Yazoo Backwater Area. The Corps also has an extensive backlog of promised, but uncompleted, mitigation as documented in its multiple annual mitigation status reports submitted to Congress.[336]

For example, according to the DEIS, the Corps still must purchase and restore **an absolute minimum of 1,188 acres of cleared land** to offset adverse impacts from projects within the Yazoo Backwater area which **will not be completed until at least 2035**, and the Corps must implement an unknown amount of additional mitigation to offset levee building in the area:

> …the 1989 mitigation plan recommended the fee title acquisition and subsequent reforestation of 8,365 acres of cleared agricultural lands to fully offset the 526,950 annualized habitat units that were lost during the construction of the Yazoo Backwater Levees, which concluded in 1978. This construction included the right-of-way clearing of 5,900 acres of hardwoods and an additional 1,200 acres of estimated project-induced clearing that was projected to occur after levee construction.
>
> The 1989 Mitigation Plan recommended the acquisition of lands from willing sellers and identified several properties that were currently available. USACE satisfied this recommendation with the acquisition of the 8,807 acres of frequently flooded cleared lands referred to as the Lake George Property in 1990. The mitigation requirement was subsequently reanalyzed by USACE and USFWS in 2007 to account for time between when the construction of the Yazoo Backwater levee projects were completed in 1978 and when mitigation activities were initiated in 1991. Additionally, the USFWS rightfully argued that USACE had failed to properly account for the amount of acreage that was reforested at the Lake George Property. After removing acreage consisting of roads, levees, standing water, and other areas not suitable for planting, it was determined that 8,082 acres were reforested at Lake George. This reanalysis resulted in the determination that **an additional 3,848 acres of mitigation was required to fully offset the construction impacts associated with the Yazoo Backwater Levees**. MVK also acknowledged that it had **failed to provide compensatory mitigation for the clearing of 215.2 acres at the proposed pump station site in 1987**. In 2007, it was determined that **an additional 519 acres of compensatory mitigation would be required to account for the impacts at the pump station and the time lost between 1987 and 2007**. **This left a total compensatory mitigation burden of 12,449 acres in 2007. When considering the additional 17 years between the 2007 reformulation and the present day, the current total requirement is 12,583 acres.**
>
> Congressionally authorized funding for the purchase and restoration of mitigation lands has been received intermittently since 2007, and additional tracts totaling 3,313 acres have been

[335] DEIS, Main Report at 12.
[336] These reports can be accessed at https://www.usace.army.mil/Missions/Civil-Works/Project-Planning/Products/MitigationStatus/.

> purchased and reforested. To date, MVK has acquired a total of 11,395 acres of cleared agricultural lands within the Yazoo Basin to compensate for completed construction of the Yazoo Backwater Levees, leaving MVK **approximately 1,188 acres short** of completely fulfilling the mitigation requirements. MVK currently has funding in hand to purchase additional mitigation property, and continues to work toward satisfying the total requirement required to fully offset the impacts of previous Yazoo Backwater Levee construction**. USACE estimates that these outstanding mitigation obligations will be satisfied by 2035**.
>
> * * *
>
> In addition, mitigation is required for uncompleted construction within the Rocky Bayou area. MVK improved 3.7 miles of a 25-mile local levee system along with one water control structure before 1980; however, **mitigation for these activities never occurred.** The team is currently calculating impacts and will add the acreage to the backlog mitigation in the Final Environmental Impact Statement.[337]

The Conservation Organizations also note that these historic mitigation numbers likely significantly understate the actual amount of mitigation needed to fully mitigate for the "damages to ecological resources, including terrestrial and aquatic resources, and fish and wildlife losses"[338] from these projects as required by law. For example, we have been advised the mitigation for the Yazoo Backwater Levee was based on the wetlands impacted by the footprint of the levee and was not based on the full suite of highly significant direct and indirect impacts.

1. The DEIS Does Not Comply with Longstanding NEPA Mitigation Requirements

The DEIS does not comply with longstanding NEPA mitigation requirements. As discussed throughout these comments, the DEIS does not meaningfully assess project impacts which is the fundamental first step in assessing mitigation needs.[339] Instead, the DEIS fails to take any steps to assess a wide array of impacts, and drastically understates those impacts that it does consider. As a result, the DEIS does not—and cannot—comply with NEPA, which requires that the DEIS analyze mitigation measures with "sufficient detail to ensure that environmental consequences have been fairly evaluated."[340]

A "perfunctory description" of the mitigating measures is not sufficient.[341] As the Supreme Court has noted, this is because:

> omission of a reasonably complete discussion of possible mitigation measures would undermine the 'action-forcing' function of NEPA. Without such a discussion, neither the agency nor other interested groups and individuals can properly evaluate the severity of the adverse effects. An adverse effect than can be fully remedied by, for example, an inconsequential public expenditure is certainly not as serious as a similar effect that can

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[337] DEIS, Main Report at 11-12.
[338] 33 U.S.C. § 2283(d).
[339] Indeed, despite carrying out multiple studies on the Yazoo Pumps over many decades, the Corps has never assessed the full extent of the wetland impacts from the Yazoo Pumps, the full array of fish and wildlife impacts from the project, or any of the stream impacts from the project.
[340] Robertson v. Methow Valley Citizens Council, 490 U.S. 332, 352 (1989).
[341] Neighbors of Cuddy Mountain v. U.S. Forest Service, 137 F.3d 1372, 1380 (9th Cir.1998).

> only be modestly ameliorated through the commitment of vast public and private resources.[342]

The DEIS also must discuss the effectiveness of the proposed mitigation:

> An essential component of a reasonably complete mitigation discussion is an assessment of whether the proposed mitigation measures can be effective. The Supreme Court has required a mitigation discussion precisely for the purpose of evaluating whether anticipated environmental impacts can be avoided. A mitigation discussion without at least *some* evaluation of effectiveness is useless in making that determination.[343]

This should include a discussion of how the mitigation will effectively address temporal losses (i.e., it takes many years to restore a fully functioning, mature wetland and many decades to restore a fully functioning mature bottomland hardwood wetland forest), and how mitigation for wetland losses can be effectively carried out in areas that would be drained by the Yazoo Pumps Alternatives. A bald assertion that mitigation will be successful is not sufficient. The effectiveness must instead be supported by "substantial evidence in the record."[344]

A discussion of the effectiveness is particularly critical because, despite progress in this area, wetland and stream mitigation often fails or does not fully replace lost ecological values. For example, the National Research Council has concluded:

> "Attempts to restore forested wetlands of the Southeast (e.g., bottomland hardwoods and cypress swamps) have encountered difficulties related to the time required to replace mature trees, the lack of material to transplant, the lack of knowledge of how and when to carry out seeding or transplantation, (Clewell and Lea, 1989) and altered hydrology (drainage for conversion to agriculture) of the wetland area. Natural forested wetlands may support hundreds of plant species, many of which thrive in the understory (91 percent of 409 species in one riverine forest were understory species). Old-growth forests are dominated by trees that gradually achieve a dominant role in the canopy and that are self-sustaining through their ability to reproduce in their own shade. It is not clear that such climax species can be successfully established in open sites, or whether their introduction must await development of seral (intermediate successional stage) plant communities. Clewell and Lea (1989) noted the need for intensive site preparation to reduce competition between weeds and transplanted tree seedlings. Their review was the first to mention insect herbivory and fire as potential problems. In many cases, restoration of suitable hydrologic conditions will be necessary. The short time period within which forest restoration attempts have been monitored precludes an evaluation of their functional equivalency with natural reference systems."[345]

The Corps also recognizes that it is particularly difficult to mitigate adverse impacts to riverine wetlands:

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[342] Id.
[343] South Fork Band Council v. Dept. of Interior, 588 F.3d 718, 727 (9th Cir. 2009) (internal citations omitted).
[344] Wyoming Outdoor Council v. U.S. Army Corps of Eng'rs, 351 F. Supp. 2d 1232, 1252 (D. Wyo. 2005).
[345] National Research Council, Restoration of Aquatic Ecosystems: Science, Technology, and Public Policy (1992) at 311-12.

> "Creation of riverine wetlands is difficult because rivers are highly integrated into existing landforms. Geomorphic features in particular may have required millennia to develop. Consequently, compensatory mitigation for degradation of riverine wetland functions seldom can be accomplished by creating new ones given the scarcity of appropriate sites."[346]

Because the DEIS does not include a meaningful discussion of mitigation or the effectiveness of the proposed mitigation, the DEIS has not taken the mandated "hard look" at the environmental impacts of the proposed action and alternatives to the action and fails to provide "a clear basis for choice among options by the decisionmaker."[347]

2. The DEIS Does Not Comply with Longstanding Water Resources Development Act Mitigation Requirements

The DEIS does not comply with the longstanding mitigation requirements established by the Water Resources Development Act. As discussed throughout these comments, the DEIS does not meaningfully assess project impacts which is the fundamental first step in assessing mitigation needs[348] Instead, the DEIS fails to take any steps to assess a wide array of impacts. For the impacts it does consider, the DEIS drastically understates both the level and significance of the damage that will be caused and the mitigation that will be needed to offset that damage.

In short, the DEIS does not assess—and has not proposed—the amount and type of mitigation that would be needed to offset the full suite of "damages to ecological resources, including terrestrial and aquatic resources, and fish and wildlife losses"[349] from the Yazoo Pumps Alternatives, as required by law.

Provisions established through several Water Resources Development Acts require the Corps to mitigate all losses to fish and wildlife created by a project unless the Secretary determines that the adverse impacts to fish and wildlife would be "negligible."[350] As highlighted above, the DEIS does not propose enough, or the types of, mitigation needed to offset all "damages to ecological resources, including terrestrial and aquatic resources, and fish and wildlife losses."[351]

The Water Resources Development Acts also require the Corps to purchase mitigation lands for Corps civil works projects must be purchased before any construction begins.[352] Any physical construction required for purposes of mitigation should be undertaken prior to project construction but must, at the latest, be undertaken "concurrently with the physical construction of such project."[353] The DEIS makes

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[346] Brinson, M.M., et al. 1995. A Guidebook for Application of Hydrogeomorphic Assessments to Riverine Wetlands. Wetlands Research Program Technical Report WRP-DE-11 at 7.
[347] 40 C.F.R. § 1502.14.
[348] Indeed, despite carrying out multiple studies on the Yazoo Pumps over many decades, the Corps has never assessed the full extent of the wetland impacts from the Yazoo Pumps, the full array of fish and wildlife impacts from the project, or any of the stream impacts from the project.
[349] 33 U.S.C. § 2283(d).
[350] 33 U.S.C. § 2283(d)(1).
[351] 33 U.S.C. § 2283(d).
[352] 33 U.S.C. § 2283(a).
[353] Id.

it clear that this is extremely unlikely since it will take the Corps **until at least 2035** to complete the purchase of mitigation lands for the Yazoo Backwater Levee that was **completed in 1978**.[354]

The DEIS also fails to comply with the mitigation planning requirements established by the Water Resources Development Acts. The Corps is prohibited from selecting a "project alternative in any report" unless that report includes a "specific plan to mitigate fish and wildlife losses."[355]

Corps mitigation plans must ensure that "impacts to bottomland hardwood forests are mitigated in-kind and harm to other habitat types are mitigated to not less than in-kind conditions, to the extent possible."[356] Mitigation plans "shall include, at a minimum" each of the following components[357]:

(1) The type, amount, and characteristics of the habitat being restored, a description of the physical actions to be taken to carry out the restoration, and the functions and values that will be achieved.

(2) The ecological success criteria, based on replacement of lost functions and values, that will be evaluated and used to determine mitigation success.

(3) A description of the lands and interest in lands to be acquired for mitigation, and the basis for determining that those lands will be available.

(4) A mitigation monitoring plan that includes the cost and duration of monitoring and identifies the entities responsible for monitoring if it is practicable to do so (if the responsible entity is not identified in the monitoring plan it must be identified in the project partnership agreement that is required for all Corps projects). Corps mitigation must be monitored until the monitoring demonstrates that the ecological success criteria established in the mitigation plan have been met.

(5) A contingency plan for taking corrective action in cases where monitoring shows that mitigation is not achieving ecological success as defined in the plan.

Corps mitigation plans must also comply with "the mitigation standards and policies established pursuant to the regulatory programs" administered by the Corps.[358]

Corps mitigation must be monitored until the monitoring demonstrates that the ecological success criteria established in the mitigation plan have been met. The Corps is also required to consult yearly on each project with the appropriate Federal agencies and the states on the status of the mitigation efforts. The consultation must address the status of ecological success on the date of the consultation, the likelihood that the ecological success criteria will be met, the projected timeline for achieving that success, and any recommendations for improving the likelihood of success.[359]

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[354] DEIS, Main Report at 11-12.
[355] 33 U.S.C. § 2283(d).
[356] 33 U.S.C. § 2283(d)(1).
[357] 33 U.S.C. § 2283(d).
[358] 33 U.S.C. § 2283(d).
[359] 33 U.S.C. § 2283(d).

The DEIS Compensatory Mitigation Plan does not meet these mandatory requirements. Instead, the plan recommends a general approach that relies on a combination of flawed strategies:

> "The recommended plan for compensatory mitigation for the Yazoo Backwater Management Project is to pursue a combination of mitigation strategies to meet the full mitigation need and includes:
>
> • Purchase of in-kind credits from the Ducks Unlimited, Inc. Mississippi Delta In Lieu Fee Program (approved: 24 September 2010) located in the YSA if they are available.
> • Purchase of In-Kind Mitigation Bank Credits located in the YSA (will only meet partial mitigation needs due to the availability of credits)
> • Construction of a YSA specific Mitigation Project
> • Management of Agricultural Area Inundation for Shorebirds."[360]

The DEIS does not include any of the required plan components for these options. Instead, it defers all detailed planning for the in-lieu-fee and mitigation bank options to those programs, and it does not provide any of the required mitigation plan components for construction or management that would be carried out by the Corps. The DEIS does not even provide information on whether credits currently are available, or likely will be available from the identified in lieu fee program or the mitigation banks, even though this information presumably could be obtained through a few phone calls or online searches. Moreover, because specific mitigation sites have not been identified, it is not possible to determine such things as: the current conditions of the sites; whether the sites have the required hydrology to support wetland functions or have the capacity to have their hydrology restored to the point of providing meaningful wetland benefits; whether the sites will also be adversely affected by the Yazoo Pumps Alternatives; the types of actions needed to achieve mitigation success at those sites; or the degree of mitigation benefits that could be obtained from restoring those sites. Specific mitigation sites must be identified and fully evaluated before construction begins.

M. The DEIS Does Not Evaluate the Highly Effective and Practicable and Resilience Alternative

The DEIS fails to evaluate a highly practicable and demonstrably effective Resilience Alternative[361] that has repeatedly been recommended by the Conservation Organizations. This Resilience Alternative consists of demonstrably effective and practicable measures that could be quickly implemented without causing any of the highly significant harm that would be caused by the Yazoo Pumps Alternatives. The types of measures included in the Resilience Alternative have repeatedly been called for by Yazoo Backwater Area community leaders and residents, County hazard mitigation plans, the U.S. Fish and Wildlife Service, and EPA.

The Resilience Alternative utilizes sustainable solutions that are being employed by communities across the country to reduce flood risks, including purchasing wetland reserve and floodplain easements, voluntary buyouts and relocations, and flood-proofing infrastructure (including elevating homes, buildings and roads). These solutions can be carried out under existing federal programs that are currently funded and available for use in the Yazoo Backwater Area, including: U.S. Department of Agriculture easement programs; Federal Emergency Management Agency pre-disaster mitigation

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[360] DEIS, Appendix J Compensatory Mitigation Plan at 39.
[361] The Conservation Organizations have shared this Resilience Alternative with the Corps and other federal agencies on multiple occasions.

programs (the Building Resilient Infrastructure and Communities "BRIC" program); and Federal Emergency Management Agency post-disaster recovery programs.[362]

Importantly, communities and community leaders in the Yazoo Backwater Area have repeatedly called for prompt implementation of the types of solutions proposed in the Resilience Alternative, as discussed above. The Yazoo Backwater Area towns of Rolling Fork and Mayersville requested assistance in developing non-structural and natural infrastructure solutions in their application for a FEMA Direct Technical Assistance Grant (managed through the BRIC Grant Program), which was submitted on November 10, 2022, and awarded in May 2023. All Yazoo Backwater Counties have submitted natural hazard mitigation plans to FEMA that prioritize non-structural and natural infrastructure solutions that reduce flood risk.

The Resilience Alternative calls for advancing the following actions in the Yazoo Backwater Area:

1. Wetland Protection and Restoration

Restoring and protecting wetlands is a highly practicable solution with a demonstrated record of reducing flood damages, as highlighted above. Restoring wetlands in the Yazoo Backwater Area to alleviate flooding instead of building the Yazoo Pumps would also: (i) avoid the many adverse impacts from the pumps, including diverting floodwaters onto other highly vulnerable communities; (ii) provide vital wildlife habitat for hundreds of fish and wildlife species and many millions of migratory birds and waterfowl; (ii) improve water quality, including by reducing nutrient runoff into the Yazoo and Mississippi Rivers; (iv) sequester carbon[363]; (v) make wildlife and communities more resilient to climate change; and (vi) reduce federal farm subsidy payments.[364]

Restoring and protecting wetlands in the Yazoo Backwater Area is clearly practicable as demonstrated by the acres in the Yazoo Backwater Area that already have been enrolled in the USDA Wetland Reserve Easement Program, which is one of the primary mechanisms for restoring and protecting wetlands (see Figure 5 below).

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[362] Post-disaster recovery funds and programs are available for at least one year after a Presidential Emergency Declaration, and eligibility can be extended for an additional 180 days.

[363] Wildlife Mississippi, The Carbon for the Trees: Carbon Sequestration in Forests of the Mississippi Alluvial Valley, August 2019, prepared for the Walton Family Foundation at 10 (citing the Conservation Fund) ("Each tree planted in the MAV absorbs approximately 1 ton of carbon dioxide over its lifetime. The typical reforestation project in the MAV involves planting 302 trees per acre."); Shoch, David T., G. Kaster, A. Hohl, R. Souter, Carbon Storage of Bottomland Hardwood Afforestation in the Lower Mississippi Valley USA, Wetlands, 2009 (concluding that one acre of bottomland hardwood forest in the Mississippi Alluvial Valley can remove and store the equivalent of 328 metric tons of CO_2 over 100 years).

[364] See Discussion of farm subsidy payments in the Yazoo Backwater Area in Section N.1 of these comments.

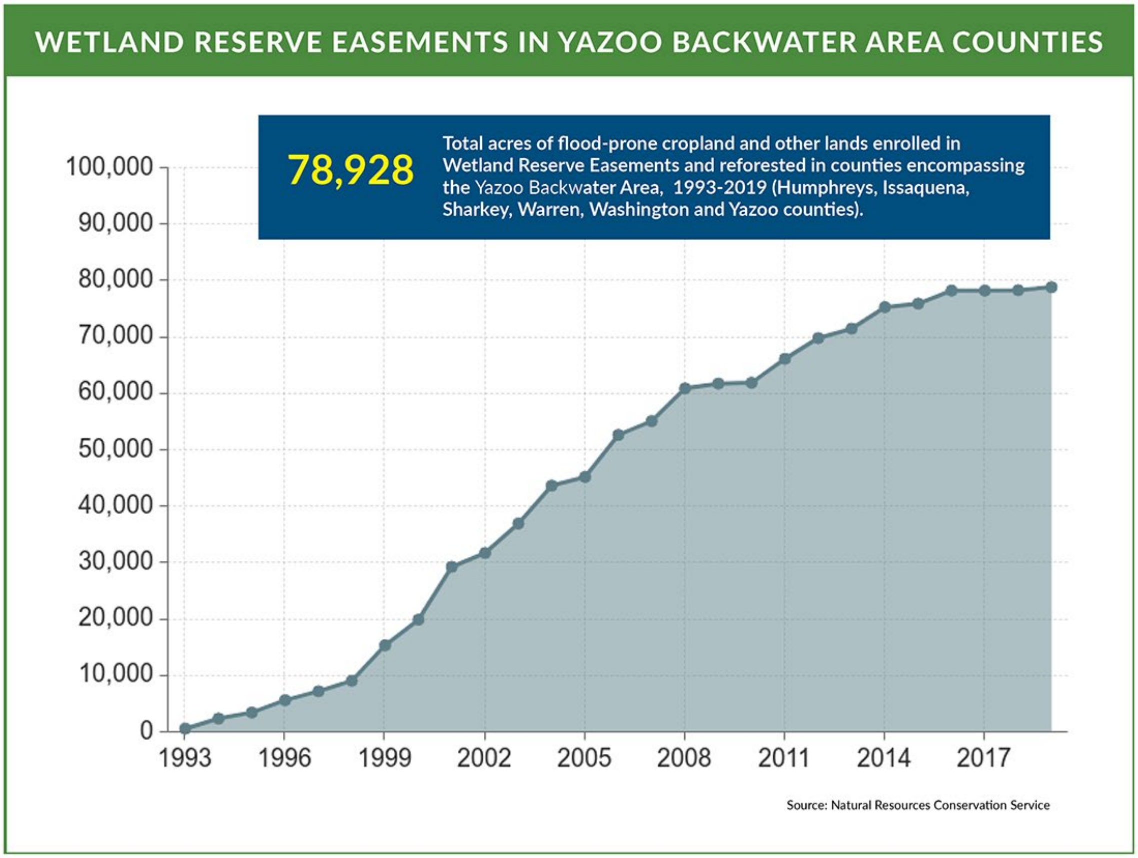

Figure: Wetland Reserve Easements in Yazoo Backwater Counties, 1993-2019 (Source: NRCS)

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As of FY2024 at least 59,786 acres of NRCS easements within the portions of these counties located within the Yazoo Backwater Area and applications have been filed for an additional 5027 acres of easements, according to information provided by the USDA Natural Resources Conservation Service:

NRCS Easements in the Yazoo Backwater Area for Fiscal Year 2024

Easements by County in the Yazoo Backwater Area

	# Easements	Acres
Humphreys	68	15476.46
Issaquena	33	18645.15
Sharkey	53	19681.42
Warren	22	3949.01
Washington	13	1891.46
Yazoo	1	142.76
Grand Total	**190**	**59786.26**

Easements by Program in the Yazoo Backwater Area

	# Easements	Acres
ACEP-WRE	21	2320.17
EWPP-FPE	6	1492.26
WRP	163	55973.83
Grand Total	**190**	**59786.26**

ACEP-WRE Applications in the Yazoo Backwater Area (FY2024)

	# Applications	Acres
Humphreys	17	1175.67
Issaquena	8	1554.7
Sharkey	3	698.69
Warren		
Washington	2	359.33
Yazoo	2	1238.7
Grand Total	**32**	**5027.09**

The practicability of protecting and restoring wetlands in the Yazoo Backwater Area is also demonstrated by the high demand for the Wetland Reserve Easement Program in Mississippi and throughout the Lower Mississippi Valley states. The Wetland Reserve Easement Program is oversubscribed in this region, which of course, means that many agricultural producers in the Yazoo Backwater Area want to take some of their marginal croplands out of production and restore the wetlands on those lands. Notably, there are no county or other caps limiting the acreage of marginal croplands with 4W+ soils that can be enrolled in Wetland Reserve Easements in the Yazoo Backwater Area.

Data compiled by the NRCS shows that more than 1,000 separate Wetland Reserve Easement applications were pending in Arkansas, Louisiana, Kentucky, Mississippi, Missouri and Tennessee in FY2019. *See* Figure, below. But just 98 were funded that year, enrolling 18,534 acres at a cost of $71 million. This represents just 10% of lands that owners currently want to enroll and restore in the Lower Mississippi Valley states. Unfunded applications roll over from year to year, and efforts are underway to encourage Congress to increase funding to address the backlog in this program.

Wetland Reserve Easements in the Lower Mississippi Valley States Pending Applications and Funded Easements for FY 2019						
State	Applications	Value	Acres	Easements Funded	Value	Acres Enrolled
Arkansas	116	$91,548,905	28,639	20	$12,244,691	4,339
Kentucky	19	$22,691,157	4,388	13	$7,700,000	1,354
Louisiana	339	$194,540,500	62,333	31	$16,911,697	5,028
Mississippi	309	$175,134,388	60,172	18	$16,631,186	3,801
Missouri	182	$69,963,059	15,085	9	$12,833,949	2,364
Tennessee	47	$17,338,134	5,521	7	$5,174,571	1,648
Total	**1,012**	**$571,216,143**	**176,138**	**98**	**$71,496,094**	**18,534**

Figure: WRE Easement Requests Lower Mississippi Valley States (Source: NRCS)

The practicability of restoring and protecting wetlands in the Yazoo Backwater Area is also demonstrated by the fact that more than 250,000 acres in the Yazoo Backwater Area are already protected and managed as wetland resources for conservation and mitigation purposes. And critically, there is substantial interest in—and a significant need for—restoring forested and other wetlands in the Yazoo Backwater Area, as evidenced by the 2020 Lower Mississippi Valley Joint Venture Conservation Priorities in the Yazoo Backwater Area (see Figure, below).[365] The U.S. Fish and Wildlife Service highlighted that Yazoo Backwater Area is the area with the "greatest potential" for meeting breeding bird habitat restoration and protection needs within the Mississippi Alluvial Valley in Fish and Wildlife Coordination Act Report prepared for the Yazoo Pumps 2007 SEIS.[366]

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[365] Elliott, A.B.; Mini, A.E.; McKnight, S.K.; Twedt, D.J. Conservation–Protection of Forests for Wildlife in the Mississippi Alluvial Valley. *Forests* 2020, *11*, 75 (available at https://www.mdpi.com/1999-4907/11/1/75. The GIS data associated with this study can be accessed at https://www.sciencebase.gov/catalog/item/5dd30670e4b069579762839c.

[366] U.S. Fish and Wildlife Service, Fish and Wildlife Coordination Act Report (October 23, 2006), 2007 Final SEIS, Appendix 3 at 7.

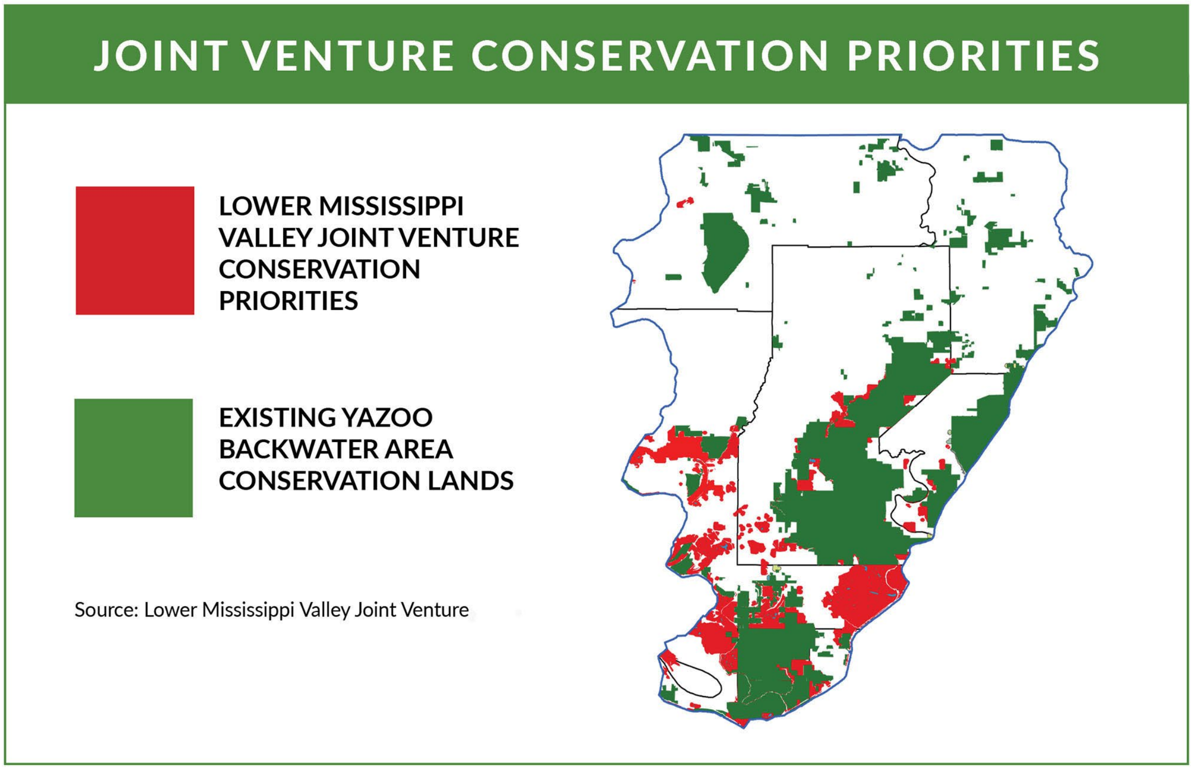

Figure: Lower Mississippi Valley Joint Venture 2020 Yazoo Backwater Area Conservation Priorities

Reforestation of the wettest lands in the Yazoo Backwater Area is a conservation priority, and there are no limitations (*i.e.*, there are no county caps) on enrolling these lands in the Wetland Reserve Easement Program. Most of the 250,000 acres of conservation lands in the Yazoo Backwater Area have been established on the wettest soils. These wet soils, commonly known as 4W+ lands, are classified by USDA as "severely limited" for farming and are exempt from county caps on Wetland Reserve Easements. There are at least 46,000 acres of 4W+ lands in the Yazoo Backwater Area that are not in conservation, many of which are adjacent to existing conservation lands (*see* Figure below). Reforestation of remaining unprotected 4W+ lands is a conservation priority. Investments to increase Wetland Reserve Easement Program enrollments would greatly improve the financial security of farmers who plant crops on marginal lands.

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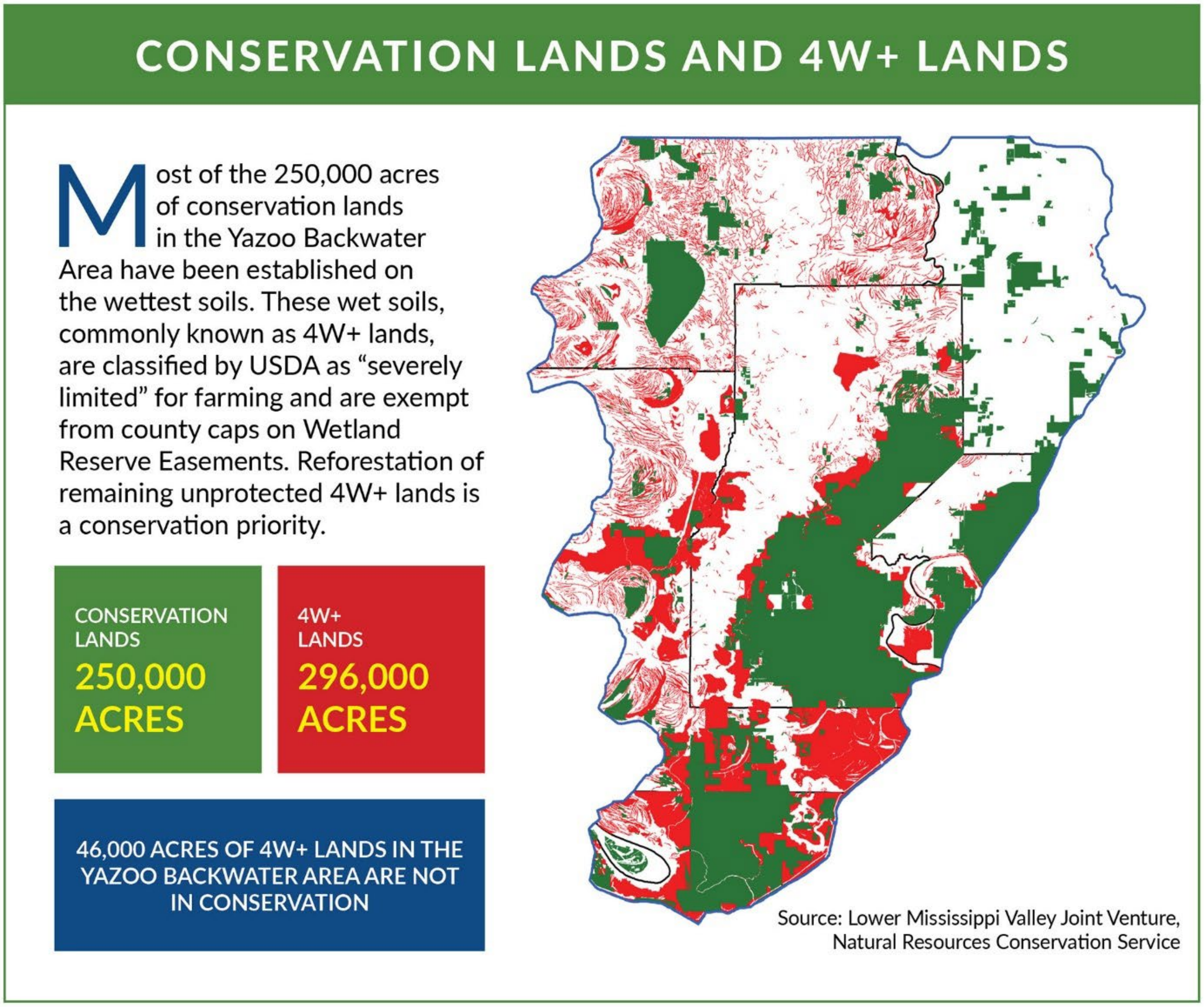

Figure: Conservation Lands and 4W+ Lands in the Yazoo Backwater Area

The practicability of wetland protection and restoration is also demonstrated by a $4.55 million project recently announced by the Mississippi Department of Environmental Quality. This project, "Migratory Bird Habitat Creation in the Lower Mississippi River Valley"[367], will be funded through the National Fish and Wildlife Foundation's (NFWF) Gulf Environmental Benefit Fund as part of the state's recovery to the 2010 Deepwater Horizon oil disaster.

The goal of this $4.55 million project is to create and enhance over 7,600 acres of migratory bird habitat in the Lower Mississippi River Valley to benefit waterfowl, shorebirds, and wading birds. This proposal focuses on public lands, namely state-managed Wildlife Management Areas and National Wildlife Refuges, which will serve to complement a similar NFWF-funded project from years ago that focused on private lands located in the same geography. The proposal will benefit public lands in seven counties, five of which are in the Yazoo Backwater Area, namely Humphreys, Issaquena, Sharkey, Warren, and Yazoo (see Figure below). This effort demonstrates there is widespread, sustained interest to direct

[367] Mississippi Department of Environmental Quality, *Migratory Bird Habitat Creation in the Lower Mississippi River Valley*, Accessed from www.restore.ms on November 16, 2020 *(available at https://www.mdeq.ms.gov/wp-content/uploads/2020/11/NFWF-Migratory-Bird-Habitat-Creation-in-the-Lower-Mississippi-River-Valley-2020.pdf)*.

further investments in the habitat conservation, protection, and management of this critical ecoregion, particularly the Yazoo Backwater Area. The Yazoo Pumps only serve to undermine efforts like these.

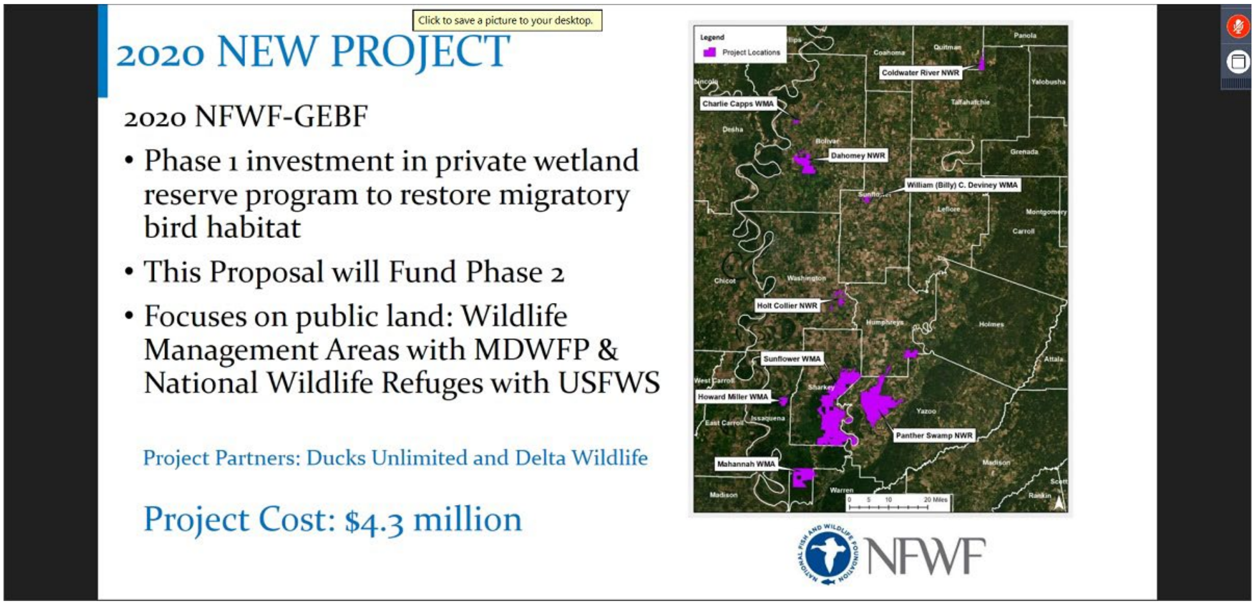

Figure: Migratory Bird Habitat Creation in the Lower Mississippi River Valley project announced on November 10, 2020, by the State of Mississippi (Source: Mississippi Department of Environmental Quality, 2020 "Virtual" Restoration Summit public webinar)

The practicability of wetland protection and restoration is further evidenced by the U.S. Fish and Wildlife Service's approval of the acquisition of 34,682 acres to expand the boundaries of National Wildlife Refuges in the Yazoo Backwater Area, including the approved 24,600 acres of acquisition approved for the Theodore Roosevelt National Wildlife Refuge Complex and Holt Collier National Wildlife Refuge.[368]

2. Pre-Disaster Mitigation and Protection

Pre-disaster hazard mitigation is a highly practicable solution with a demonstrated record of reducing flood damages. On average, $1 spent on hazard mitigation through a federally funded mitigation grant saves $6 in future disaster costs. Federal grants provide $7 in benefits for each $1 invested in riverine flood mitigation. Hazard mitigation actions reduce the risk of damage from future high water events, improve community safety, increase community resilience, minimize flood disaster disruptions, and allow more rapid recovery when flooding does occur. To advance these solutions, FEMA should prioritize pre-disaster mitigation funds and assistance to Yazoo Backwater Area communities.

Pre-disaster mitigation planning and funding is clearly practicable as evidenced by the many federal grant programs available to carry out this type of work and the applicable county hazard mitigation plans. The practicability of pre-disaster mitigation is also evidenced by the award of a FEMA non-financial Direct Technical Assistance Grant to the towns of Rolling Fork and Mayersville, which was

[368] U.S. Fish and Wildlife Service, Theodore Roosevelt and Holt Collier National Wildlife Refuges Comprehensive Conservation Plan, October 2015 at 3, 40; U.S. Fish and Wildlife Service, Theodore Roosevelt National Wildlife Refuge Complex Hillside, Mathews Brake, Morgan Brake, Panther Swamp, and Yazoo National Wildlife Refuges, February 2006 at 109.

announced on May 19, 2023. Through this grant, FEMA will provide "direct technical assistance to mitigate flood risk hazards and holistically improve the resilience of [Rolling Fork and Mayersville] through sustainable, cost-effective non-structural, natural, and nature-based measures."

The practicability of implementing these types of measures through pre-disaster mitigation planning and protection is also demonstrated by the letters requesting implementation of such measures from Yazoo Backwater Area community leaders and residents. See General Comment section of these comments. The practicability of implementing these types of measures is also demonstrated by the fact that all the Yazoo Backwater Area Counties have submitted natural hazard mitigation plans to FEMA that include non-structural and natural infrastructure solutions to reduce flood risk.

3. Elevate Low-Lying Road Segments

Road elevations are a well-recognized approach to ensuring access during flood events, and are eminently practicable. Targeted road elevations in the Yazoo Backwater Area would help ensure that Yazoo Backwater Area residents can access homes, businesses, and essential services during flood events. This work can be carried out through targeted use of Department of Transportation and other applicable programs and funding. Key road elevation needs have already been documented, and include the following low-lying road segments that flooded during the 2019 flood, according to the Mississippi Levee Board:

Road	Elevation of Flooded Segment	Elevation of Floodplain 2007 EIS NGVD[369]
Blanton Road	92.0 feet	Below 5-year floodplain *(elevation 94.6 feet NGVD)*
Spanish Fort Road	92.5 feet	Below 5-year floodplain *(elevation 94.6 feet NGVD)*
Goose Lake Road	93.4 feet	Below 5-year floodplain *(elevation 94.6 feet NGVD)*
Low Water Bridge Road	93.7 feet	Below 5-year floodplain *(elevation 94.6 feet NGVD)*
Highway 16 Delta National Forest segment Between Rolling Fork and Holly Bluff	96.0 feet	Below 10-year floodplain *(elevation 96.3 feet NGVD)*
Satartia Road Segment East of Holly Bluff	None provided	

4. Post-Disaster Recovery Assistance

Effective use of post-disaster recovery funds is highly effective for reducing future flood risks and improving resilience, and highly practicable. Post disaster recovery funds are made available after every federal disaster declaration that covers the Yazoo Backwater Area.

Notably, when such funds are used to assist in rebuilding substantially damaged structures, those structures must be elevated and floodproofed in accordance with the Federal Flood Risk Management

[369] According to the 2007 FSEIS, the 5-year floodplain elevation is 94.6 feet NGVD and the 10-year floodplain elevation is 96.3 feet NGVD. 2007 FSEIS, Appendix 6 at 6-44.

Standard regardless of the type of disaster that caused the damage. For example, structures substantially destroyed by the March 2023 tornados that devastated Rolling Fork and other areas of Sharkey County must be elevated and floodproofed—and are being elevated and floodproofed—in accordance with the Federal Flood Risk Management Standard. Since elevations and floodproofing are already being implemented by FEMA and the Mississippi Emergency Management Agency in the Yazoo Backwater Area, both actions are clearly both feasible and practicable.

Since 2016, the Yazoo Backwater Area has suffered from six federally declared Major Disasters resulting from floods, storms, and winds, and future disasters are likely to occur:

Mississippi Severe Storms, Straight-line Winds, and Tornadoes (DR-4697-MS)
Incident Period: March 24, 2023 - March 25, 2023
Major Disaster Declaration declared on March 26, 2023
Sharkey, Humphreys, and Washington Counties

Mississippi Hurricane Ida (DR-4626-MS)
Incident Period: August 28, 2021 – September 1, 2021
Major Disaster Declaration declared on October 22, 2021
Sharkey and Issaquena Counties

Mississippi Hurricane Delta (EM-3548-MS)
Incident Period: October 7, 2020 – October 11, 2020
Emergency Declaration declared on October 8, 2020
Sharkey and Issaquena Counties

Mississippi Severe Storms, Flooding, and Mudslides (DR-4538-MS)
Incident Period: February 10, 2020 – February 18, 2020
Major Disaster Declaration declared on April 23, 2020
Sharkey and Issaquena Counties

Mississippi Severe Storms, Straight-line Winds, Tornadoes, and Flooding (DR-4429-MS)
Incident Period: February 22, 2019 – March 29, 2019
Major Disaster Declaration declared on April 23, 2019
Sharkey and Issaquena Counties

Mississippi Severe Storms and Flooding (DR-4268-MS)
Incident Period: March 9, 2016 – March 29, 2016
Major Disaster Declaration declared on March 25, 2016
Issaquena County

As discussed in Section N.2 of these comments, the types of measures included in the Resilience Alternative are demonstrably effective. The DEIS must fully and comprehensively evaluate the Resilience Alternative, which should be recommended **in lieu of** the Yazoo Pumps Alternatives.

N. The DEIS Does Not Rigorously Explore and Objectively Evaluate Reasonable Alternatives and Does Not Select an Alternative that Protects and Restores the Yazoo Backwater Area

To comply with NEPA, the DEIS must rigorously explore and objectively evaluate reasonable alternatives which are defined to mean "a reasonable range of alternatives that are technically and economically feasible and meet the purpose and need for the proposed action."[370] Critically, the DEIS is not to be used to justify a decision that has already been made.[371]

The Water Resources Development Act of 2007 directs that all water resources projects are to reflect national priorities by "protecting and restoring the functions of natural systems."[372] The Water Resources Development Acts also require the Corps to consider non-structural, natural, and nature-based measures when planning water resources projects.[373]

The Clean Water Act 404(b)(1) Guidelines prohibit the Corps from proceeding with a civil works project unless the Corps demonstrates that the project is the least environmentally damaging practicable alternative,[374] which can only be done by examining a full range of reasonable alternatives. "An alternative is practicable if it is available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes."[375]

In developing and selecting alternatives, the DEIS also must comply with the full suite of federal laws and policies designed to protect the environment. These include the Endangered Species Act, the Clean Water Act, the Fish and Wildlife Coordination Act, the Migratory Bird Treaty Act, and the mitigation requirements applicable to Corps civil works projects.[376] The alternative ultimately recommend by the EIS must also obtain a Clean Water Act water quality certification from the State of Mississippi.

In short, the DEIS must evaluate a range of reasonable alternatives—including nonstructural, natural, and nature-based solutions that alone or in combination would protect and restore the natural functions of the rivers, streams, and wetlands in the Yazoo Backwater Area. The Corps must ultimately select an alternative that achieves these objectives while causing the least possible amount of harm to the environment.

In addition to the many issues discussed in the other sections of these comments, in developing and evaluating alternative, the Corps must look beyond pre-conceived notions regarding the benefits that would be provided by the Yazoo Pumps Alternatives and instead carefully consider and account for solutions that could provide far more meaningful benefits to Yazoo Backwater Area communities.

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[370] 40 C.F.R. § 1508.1(z). The Council on Environmental Quality has long made it clear that "[r]easonable alternatives include those that are practical or feasible from a technical and economic standpoint and using common sense, rather than simply desirable from the standpoint of the applicant." Forty Most asked Questions Concerning CEQ's NEPA Regulations, 46 Fed. Reg. 18,026 (March 23, 1981).

[371] City of Bridgeton v. FAA, 212 F.3d 448, 458 (8th Cir. 2000) (quoting Citizens Against Burlington, Inc. v. Busey, 938 F.2d 190, 196 (D.C. Cir. 1991), cert. denied 502 U.S. 994 (1991); citing Simmons v. U.S. Army Corps of Eng'rs, 120 F.3d 664, 666 (7th Cir. 1997)).

[372] 42 USC 1962–3.

[373] 33 U.S.C. 701b–11(a); 33 USC § 2289a; 33 U.S.C. § 2282(2).

[374] 40 CFR 230.10(a). While the Corps does not technically issue itself a Clean Water Act 404 permit, it must satisfy the requirements of the 404(b)(1) Guidelines.

[375] 40 C.F.R. § 230.10(a).

[376] 33 U.S.C. § 2283(d).

The DEIS does not look for solutions that would meaningfully address community problems, but instead continues to propose alternatives focused on attempting to artificially control that important flood regime to benefit industrial scale agriculture in the Yazoo Backwater Area. The DEIS ignores the well-established value and effectiveness of non-structural, natural and nature-based measures that could provide meaningful solutions. The DEIS also ignores the reality that every iteration of the Yazoo Pumps that has been proposed, has ultimately been rejected.

1. The DEIS Only Examines Alternatives that Primarily Benefit Industrial Scale Agriculture

Since construction of the Yazoo Backwater Levee in 1978, the Yazoo Backwater Area has seen only one flood that reached the 25-year floodplain – during the unprecedented flooding in May 2019. Between 1978 and 2018, water levels in the Yazoo Backwater Area never reached the 20-year floodplain and exceeded the 10-year floodplain just 2 times (water levels also exceeded the 10-year floodplain for a single day in 2020).

Period of Record: 1978-October 2020

Number of Years water reached and slightly exceeded the 25 year floodplain:	1
Number of Years water reached above 10 year and below 20 year floodplain:	3
Number of Years water reached above 5 year and below 10 year floodplain:	5
Number of Years water reached above 3 year and below 5 year floodplain:	2
Number of Years water reached above 2 year and below 3 year floodplain:	5
Number of Years water reached above 1 year and below 2 year floodplain:	17
Number of Years water did not reach the 1 year floodplain:	11

Year	Peak Elevation (Feet-NGVD)	Floodplain	Flood Rank
2020	96.86	0.5 inches above 10 year	2
2019	98.23 May 23, 2019	0.23 inches above 25 year	1
2018	95.33	below 10 year	8
2017	88.46	below 2 year	25
2016	91.98	below 3 year	14
2015	95.39	below 10 year	7
2014	95.59	below 10 year	5
2013	90.94	below 2 year	16
2012	85.37	below 1 year	33
2011	89.96	below 2 year	21
2010	95.5	below 10 year	6
2009	93.74	below 5 year	9
2008	92.18	below 3 year	12
2007	85.4	below 1 year	32
2006	80.1	below 1 year	40
2005	90	below 2 year	20-tied

Year	Peak Elevation (Feet-NGVD)	Floodplain	Flood Rank
2004	84.7	below 1 year	36
2003	88.4	below 2 year	26
2002	90	below 2 year	20-tied
2001	88.7	below 2 year	24
2000	77.4	below 1 year	41
1999	90.3	below 2 year	18
1998	88.3	below 2 year	27
1997	93.3	below 5 year	10
1996	88.1	below 2 year	28
1995	87.9	below 2 year	29
1994	90.9	below 2 year	17
1993	91.5	below 3 year	15
1992	82.3	below 1 year	36
1991	92.5	below 3 year	10
1990	89.6	below 2 year	22
1989	89.7	below 2 year	21
1988	85.3	below 1 year	33
1987	84.9	below 1 year	34
1986	82.1	below 1 year	37
1985	87.1	below 2 year	29
1984	92	below 3 year	12
1983	95.8	below 10 year	3
1982	90.2	below 2 year	18
1981	80.4	below 1 year	38
1980	90	below 2 year	19-tied
1979	96.5	below 20 year	2
1978	85.7	below 1 year	30

Notably, even during the prolonged 2019 flood, which was the largest in the Yazoo Backwater Area since construction of the Yazoo Backwater Levee, Yazoo Backwater Area farmers were also able to grow 316,000 acres of crops in 2019, which is more than 55% of the 10-year average acreage of crops grown in the Yazoo Backwater Area, according to USDA data.[377] See additional discussion regarding Yazoo Backwater Area agriculture, below.

During the 2019 flood, structural damages within the Yazoo Backwater Area counties were highly concentrated with **76% of all structural damage** and **85% of all structural monetary damages** occurring in Warren County, which includes the Eagle Lake community and extensive areas located outside of the boundaries of the Yazoo Backwater Area (*see* Figure below). In 2019, relatively few structures were affected by flooding in Issaquena and Sharkey counties, the two counties located entirely within the Yazoo Backwater Area, according to Mississippi Emergency Management data. Within Issaquena and Sharkey counties a total of 53 homes and 19 mobile homes were affected. Of those, 27 homes had only

[377] USDA National Agricultural Statistics Service, CropScape Cropland Data Layer.

minor or very minor damage. Data for other counties include large areas that would not be affected by the Pumps. The targeted solutions proposed in the Resilience Alternative would provide reliable solutions to reduce flood damages for the Eagle Lake community. The Yazoo Pumps Alternatives, on the other hand, could make access to the Eagle Lake community even more difficult since the community's main access road—Highway 465—is located outside of the Yazoo Backwater Area (*i.e.*, on the riverside of the Yazoo Backwater Levee) and would be on the receiving end of the up to 16 billion gallons of water a day discharged by the Yazoo Pumps Alternatives.

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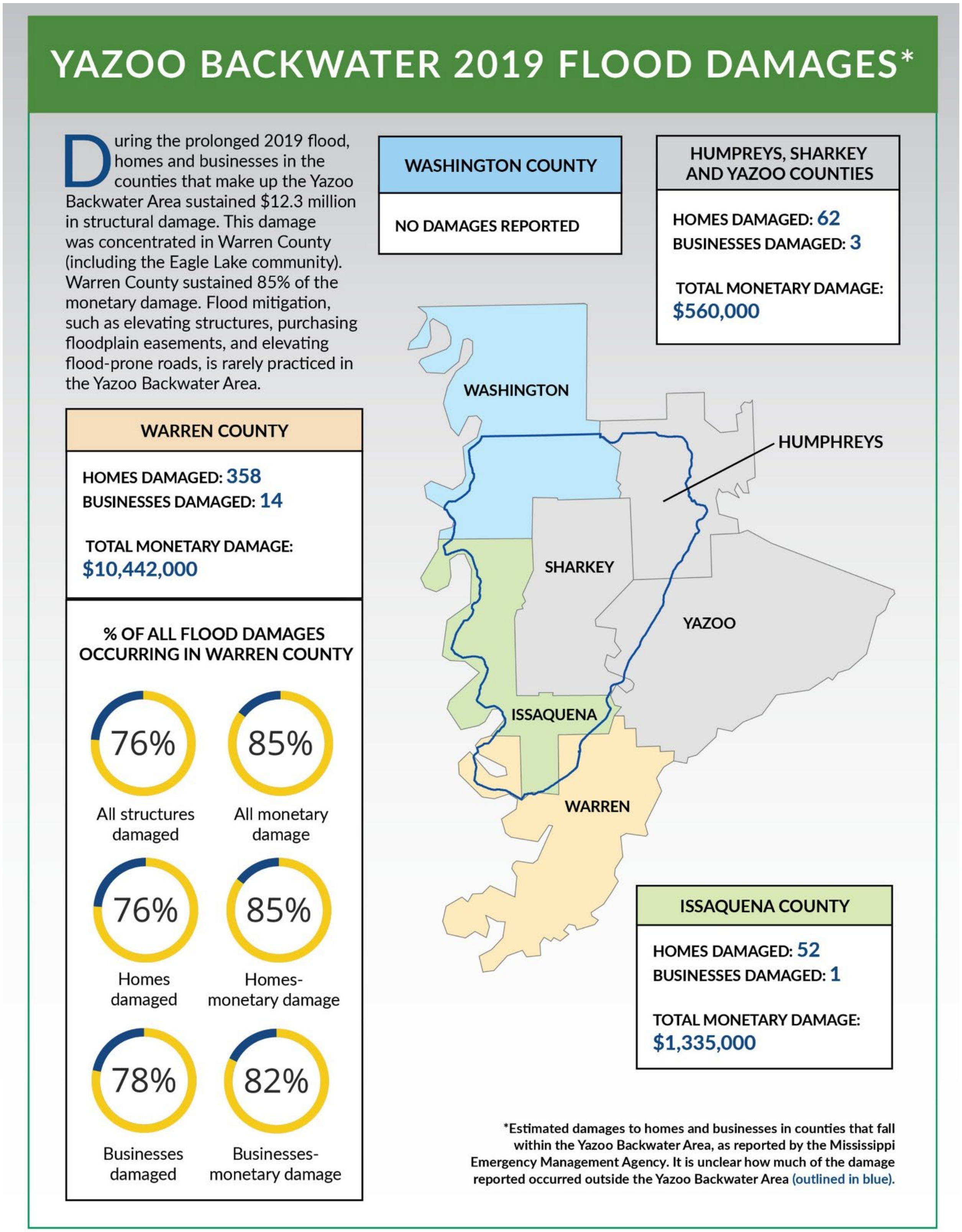

Figure: Yazoo Backwater Area 2019 Flood Damages Reported by Mississippi Emergency Management Agency

Instead of carefully considering these facts it its assessment of project need, project benefits, and project alternatives, the Corps has continued its long history of developing Yazoo Pumps proposal with a singular goal of providing benefits to the region's industrial-scale agricultural producers. Indeed, the last time the Corps assessed benefits, more than 80% of project benefits came from agricultural intensification.

Like every Yazoo Pumps plan before it, the Yazoo Pumps Alternatives are focused on facilitating agricultural production—and indeed, the entire operating plan is driven by the needs of agricultural producers by pumping water at levels expressly prohibited by the Clean Water Act veto throughout the entire 7-month crop season.

The benefits from this pumping—and the overwhelming benefits of the Yazoo Pumps Alternatives—would go to extremely large farms owned by predominantly white agricultural producers. The average sized farm in the Yazoo Backwater Area is more than 2,900 acres, while the average farm in Mississippi is just 302 acres.[378] In Sharkey County, 92% of agricultural producers are white, while 75% of the population is Black. In Issaquena County, 87% of agricultural producers are white, while 60% of the population is Black.[379]

Many of these agricultural producers already receive substantial income through federal farm subsidy payments.[380] For example USDA data compiled through the Environmental Working Group Farm Subsidy Database shows that farms in the 16 zip codes that fall within the Yazoo Backwater Area received the following subsidies between 1995 and 2019 (see Figure below):

- Yazoo Backwater Area recipients received a total of $1.05 billion in farm subsidy payments.

- The top 5 recipients in the Yazoo Backwater Area received a total of $20.5 million, $17.4 million, $15.5 million, $14.2 million, and $10.7 million, respectively.

- The top 5 recipients in each Yazoo Backwater Area zip code received a total of $430.7 million from 1995 to 2019—an average of $215,000 for each of 80 recipients every year for 25 years.

- 272 recipients received more than $1 million each from 1995 to 2019—a minimum of $40,000 a year on average for each recipient every year for 25 years.

By contrast, 25% of all households in the Yazoo Backwater Area counties of Issaquena and Sharkey earn less than $15,000 each year. In Issaquena County, 42% of the people live in poverty. In Sharkey County, 26% of the people live in poverty.

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[378] USDA, Farms and Lands in Farms 2020 Summary (February 2021). The average farm in the U.S. is just 444 acres.
[379] 2017 U.S. Department of Agriculture's Census of Agriculture. Sharkey and Issaquena counties are the only two counties located entirely within the Yazoo Backwater Area. In Mississippi as a whole, 83% of agricultural producers are white.
[380] All farm subsidy information was obtained through the Environmental Working Group Farm Subsidy Database, which compiles USDA data.

YAZOO BACKWATER AREA FARM SUBSIDIES*

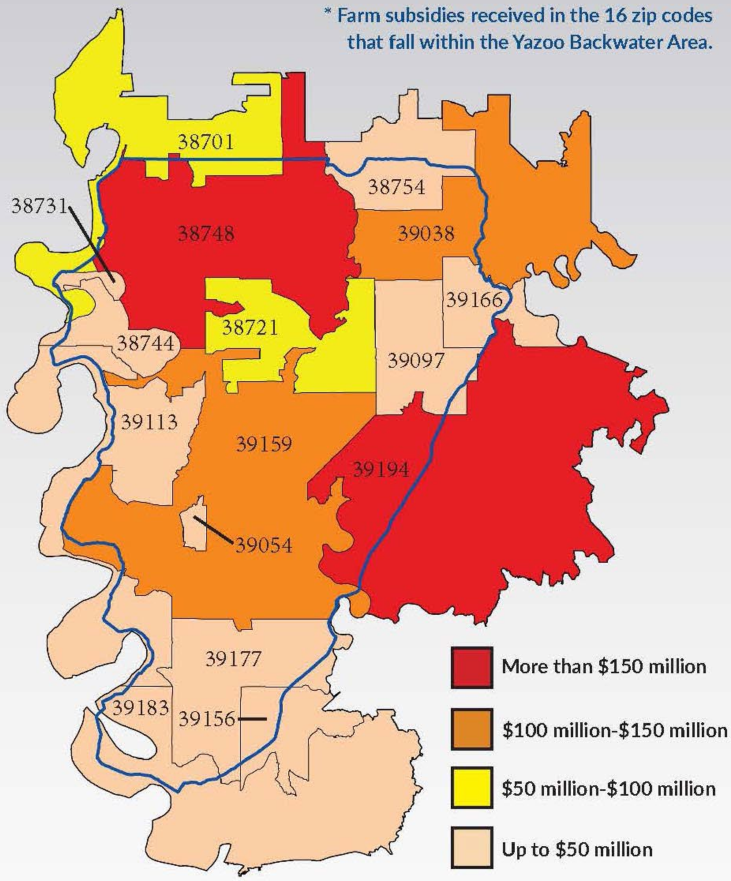
TOTAL SUBSIDIES*

$1.05 BILLION

Subsidy payments include all taxpayer-funded farm subsidies received from 1995 to 2019. Subsidies were compiled for the 16 zip codes that fall within the Yazoo Backwater Area from the Environmental Working Group Farm Subsidy Database, which compiles USDA data. Some of the zip codes extend beyond the boundary of the backwater area **(outlined in blue)**.

ZIP CODE	SUBSIDIES
39194	$206,461,849
38748	$195,420,691
39159	$148,391,998
39038	$112,189,087
38721	$77,456,356
38701	$67,762,848
39097	$49,603,235
38744	$44,373,852
38754	$26,945,846
39054	$25,504,986
39183	$25,462,913
38731	$19,659,275
39177	$18,153,356
39166	$15,032,921
39156	$12,270,589
39113	$8,484,164
TOTAL	**$1,053,173,966**

* Farm subsidies received in the 16 zip codes that fall within the Yazoo Backwater Area.



Subsidies received include commodity payments, crop insurance, disaster payments and conservation payments. From 1995 to 2019, Mississippi farmers received a total of $10.1 billion in farm subsidy payments, of which 90% were crop-related.

Nearly 60% of Mississippi farmers do not receive farm subsidies in any given year.

Figure: Yazoo Backwater Area Farm Subsidy Payments by County

Many farms in the Yazoo Backwater Area also remain very productive during flood years. For example, even during the prolonged 2019 flood event, 316,000 acres of crops were grown in the Yazoo Backwater Area. This is more than 55% of the 10-year average acreage of crops grown in the Yazoo Backwater Area, according to USDA data.[381] In 2008, then Mississippi Governor Haley Barbour stated on Mississippi Public Radio that even during the 100-year flood of 1973, farmers had good soybean crops. Indeed, we understand that many farmers prefer to plant after floods because it is cheaper to do so. Post-flood planting reduces the amount of chemicals that must be applied to the land to clear the fields and reduces the amount of fertilizer needed due to the nutrients provided by the flooding.

Producers are also compensated for crop losses resulting from flooding through the U.S. Department of Agriculture Commodity programs, Federal Crop Insurance, and Noninsured Crop Disaster Assistance programs. Only uninsured losses (less any subsidies) that could be reduced by operation of the Yazoo Pumps should be accounted for in the assessment of project benefits. The analysis of such losses must also be based on an accurate assessment of the elevation of lands on which those lost crops were planted.

2. The DEIS Does Not Consider Highly Effective Natural and Nature-Based Measures

The DEIS does not meaningfully consider highly effective natural and nature-based measures.[382] These measures must be considered by the Corps as a matter of law. Such measures should be considered and selected because they are both demonstrably effective and cost-effective.

Ample evidence demonstrates that nonstructural, natural and nature-based measures are both highly effective and cost-effective solutions for reducing flood and storm damages and that evidence continues to mount, as highlighted in the National Wildlife Federation's report on The Protective Value of Nature[383] and in the examples provided below. As aptly noted by the Reinsurance Association of America: "One cannot overstate the value of preserving our natural systems for the protection of people and property from catastrophic events."[384]

The value of wetlands for reducing flood risks has long been recognized by the Corps, including in a 1972 study evaluating options to reduce flooding along Charles River in Massachusetts where the Corps concluded:

> Nature has already provided the least-cost solution to future flooding in the form of extensive [riverine] wetlands which moderate extreme highs and lows in streamflow. Rather than attempt to improve on this natural protection mechanism, it is both prudent and economical to leave the hydrologic regime established over millennia undisturbed.[385]

[381] USDA National Agricultural Statistics Service, CropScape Cropland Data Layer.
[382] The DEIS does give lip service to voluntary acquisition of low-lying lands.
[383] Glick, P., E. Powell, S. Schlesinger, J. Ritter, B.A. Stein, and A. Fuller. 2020. The Protective Value of Nature: A Review of the Effectiveness of Natural Infrastructure for Hazard Risk Reduction. Washington, DC: National Wildlife Federation.
[384] Restore America's Estuaries, *Jobs & Dollars BIG RETURNS from coastal habitat restoration* (September 14, 2011) (http://www.estuaries.org/images/81103-RAE_17_FINAL_web.pdf).
[385] American Rivers, Unnatural Disasters, Natural Solutions: Lessons From The Flooding Of New Orleans (2006) (quoting USACE, from Massachusetts Department of Fish and Game, *Functions of Riparian Areas for Flood Control*, http://www.mass.gov/dfwele/river/pdf/riparian_factsheet_1.pdf.)

A single acre of wetland can store 1.5 million gallons of floodwaters.[386] Just a 1 percent loss of a watershed's wetlands can increase total flood volume by almost seven percent.[387] Wetlands prevented $625 million in flood damages in the 12 coastal states affected by Hurricane Sandy, and reduced damages by 20 to 30 percent in the four states with the greatest wetland coverage.[388] Coastal wetlands reduced storm surge in some New Orleans neighborhoods by two to three feet during Hurricane Katrina, and levees with wetland buffers had a much greater chance of surviving Katrina's fury than levees without wetland buffers.[389]

As an example, wetlands prevented $625 million in flood damages in the 12 coastal states affected by Hurricane Sandy, and reduced damages by 20 to 30 percent in the four states with the greatest wetland coverage.[390] The forest and other conservation lands that make up the 28,000 acre Meramec Greenway along the Meramec River in southern Missouri contribute about $6,000 per acre in avoided flood damages annually.[391] Wetlands in the Eagle Creek watershed of central Indiana reduce peak flows from rainfall by up to 42 percent, flood area by 55 percent, and maximum stream velocities by 15 percent.[392] Coastal wetlands reduced storm surge in some New Orleans neighborhoods by two to three feet during Hurricane Katrina, and levees with wetland buffers had a much greater chance of surviving Katrina's fury than levees without wetland buffers.[393]

Natural and nature-based solutions are also often more cost-effective than structural measures. A recent study documents that using natural and nature-based solutions for reducing coastal flood risks in Texas, Louisiana, Mississippi, and Florida would have a benefit-cost ratio of 3.5 compared to just 0.26 for levees and dikes. Restoring wetlands in this region could prevent $18.2 billion in losses while costing just $2 billion to carry out.[394]

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[386] Environmental Protection Agency, "Wetlands: Protecting Life and Property from Flooding." EPA 843-F-06-001. (2006) (factsheet).

[387] Demissie, M. and Abdul Khan. 1993. "Influence of Wetlands on Streamflow in Illinois." Illinois State Water Survey, Contract Report 561, Champaign, IL, Table 7, pp. 44-45.

[388] Narayan, S., Beck, M.B., Wilson, P., et al., The Value of Coastal Wetlands for Flood Damage Reduction in the Northeastern USA. Scientific Reports 7, Article number 9463 (2017), doi:10.1038/s41598-017-09269-z (available at https://www.nature.com/articles/s41598-017-09269-z).

[389] Bob Marshall, Studies abound on why the levees failed. But researchers point out that some levees held fast because wetlands worked as buffers during Katrina's storm surge, New Orleans Times-Picayune (March 23, 2006).

[390] Narayan, S., Beck, M.B., Wilson, P., et al., The Value of Coastal Wetlands for Flood Damage Reduction in the Northeastern USA. Scientific Reports 7, Article number 9463 (2017), doi:10.1038/s41598-017-09269-z.

[391] Kousky, C., M. Walls, and Z. Chu. 2014. Measuring resilience to climate change: The benefits of forest conservation in the floodplain. p 345–360. In: V.A. Sample and R.P. Bixler, eds. Forest Conservation and Management in the Anthropocene: Conference Proceedings. Proceedings RMRS-P-71. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

[392] Javaheri, A., and M. Babbar-Sebens. 2014. On comparison of peak flow reductions, flood inundation maps, and velocity maps in evaluating effects of restored wetlands on channel flooding. Ecological Engineering 73: 132–145.

[393] Bob Marshall, Studies abound on why the levees failed. But researchers point out that some levees held fast because wetlands worked as buffers during Katrina's storm surge, The New Orleans Times-Picayune (March 23, 2006).

[394] Borja G. Reguero et al., "Comparing the Cost Effectiveness of Nature-Based and Coastal Adaptation: A Case Study from the Gulf Coast of the United States," PLoS ONE 13, no. 4 (April 11, 2018), https://doi.org/10.1371/journal.pone.0192132.

Natural infrastructure also has the significant added benefits of being self-sustaining and avoiding the risk of catastrophic structural failures. Importantly, natural infrastructure can work both alone and in combination with more traditional grey infrastructure to reduce flood and storm risks.

Non-structural, natural and nature-based solutions are being used by communities across the country to reduce flood risks. For example:

- In California, the Napa Valley Flood Control Project is using a community-developed "living river" plan to reduce flood damages along the flood-prone Napa River. This plan replaces the Corps' originally-proposed floodwalls and levees with terraced marshes, wider wetland barriers, and restored riparian zones. The Project will restore more than 650 acres of high-value tidal wetlands of the San Francisco Bay Estuary while protecting 2,700 homes, 350 businesses, and over 50 public properties from 100-year flood levels, saving $26 million annually in flood damage costs.[395] Though only partially complete, the project was credited for lowering flood levels by about 2 to 3 feet during the 2006 New Year's Day flood.

- In Florida, the Corps is using wetland restoration in the Upper St. John's River floodplain to provide important flood damage reduction benefits. The backbone of this project is restoration of 200,000 acres of floodplain which will hold more than 500,000 acre-feet of water—enough to cover 86 square miles with 10 feet of water—and will accommodate surface water runoff from a more than 2,000 square mile area. The Corps predicts that this $200 million project will reduce flood damages by $215 million during a 100-year flood event, and provide average annual benefits of $14 million. This project was authorized by Congress in 1986 to reduce flood damages along the river.

- In Illinois, wetlands in the seven-county Chicago metropolitan area provide an average $22,000 of benefits per acre each year in water flow regulation, as documented by a 2014 study conducted for the Chicago Wilderness Green Infrastructure Vision. This study also found that watersheds with 30 percent wetland or lake areas saw flood peaks that were 60 to 80 percent lower than watersheds without such coverage, and that preventing building in floodplain areas could save an average of $900 per acre per year in flood damages.[396]

- In Iowa, the purchase of 12,000 acres in easements along the 45-mile Iowa River corridor saved local communities an estimated $7.6 million in flood damages as of 2009. The easement purchase effort began after the historic 1993 floods when river communities in east-central Iowa recognized the need for a more effective approach to reducing flood damages.

- In Massachusetts, the Corps recommended preserving 8,000 acres of floodplain wetlands along the Charles River after finding that upstream wetlands were playing a critical role in reducing flooding in the middle and upper reaches of the Charles River by storing millions of gallons of water and preventing $17 million each year in flood damages. This approach was sanctioned by Congress in 1974 when it authorized the Charles River Natural Valley Storage Area. Preserving

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[395] Napa County California website at https://www.countyofnapa.org/1096/Creating-Flood-Protection.

[396] Will Allen, Ted Weber, and Jazmin Varela, *Green Infrastructure Vision: Version 2.3: Ecosystem Service Valuation.* (The Conservation Fund: 2014), 13-15, https://datahub.cmap.illinois.gov/dataset/c303fd2e-beaf-4a75-a9ec-b27c6da49b69/resource/028c9b69-bb19-425e-bb92-3d33656bea4c/download/tcfcmapgiv23ecosystemservicesfinalreport201412v2.pdf.

these wetlands cost just one-tenth of the structural project the Corps had previously planned to build. These floodplain wetlands are credited with reducing major floods, including in 1979, 1982, and 2006. The Corps estimates that this project has prevented $11.9 million in flood damages while providing recreational benefits valued at between $3.2 and $4.6 million.[397]

- In New York, restoration of wetlands and lands adjacent to 19 stream corridors in Staten Island "successfully removed the scourge of regular flooding from southeastern Staten Island, while saving the City $300 million in costs of constructing storm water sewers."[398] Some 400 acres of freshwater wetland and riparian stream habitat has been restored along 11 miles of stream corridors that collectively drain about one third of Staten Island's land area. A 2018 study commissioned by the City of New York found that using "hybrid infrastructure" that combines nature, nature-based, and gray infrastructure together could save Howard Beach, Queens $225 million in damages in a 100-year storm while also generating important ecosystem services.[399]

- In Oregon, the Portland Bureau of Environmental Services restored 63 acres of wetland and floodplain habitat, restored 15 miles of Johnson Creek, and move structures out of high risk areas to reduce flood damages in the Johnson Creek neighborhood. In January 2012, when heavy rainfall caused Johnson Creek to rise two feet above its historic flood stage, the restored site held the floodwaters, keeping nearby homes dry and local businesses open. An ecosystem services valuation of the restored area found that the project would provide $30 million in benefits (in 2004 dollars) over 100 years through avoided property and utility damages, avoided traffic delays, improved water and air quality, increased recreational opportunities, and healthy fish and wildlife habitat.[400]

- In Texas, restoration of a 178-acre urban wetland—formerly an abandoned golf course—acted as a sponge to store 100 million gallons of water during Hurricane Harvey, protecting 150 homes in Houston's Clear Lake community from serious flooding. This project will store up to a half billion gallons of water and protect up to 3,000 homes when it is completed in 2021.[401]

- In Vermont, a vast network of floodplains and wetlands, including those protected by 23 conservation easements protecting 2,148 acres of wetland along Otter Creek, saved Middlebury $1.8 million in flood damages during Tropical Storm Irene, and between $126,000 and $450,000 during each of 10 other flood events. Just 30 miles upstream, in an area without such floodplain and wetland protections, Tropical Storm Irene caused extensive flooding to the city of Rutland.[402]

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[397] American Rivers, Unnatural Disasters, Natural Solutions: Lessons From The Flooding Of New Orleans (2006) (Charles River Valley Natural Storage Area case study); and https://www.arcgis.com/apps/MapJournal/index.html?appid=0bf97d033a8642b18c2e8075d4b5ecfe.

[398] Cooper Union, Institute for Sustainable Design, *The Staten Island Bluebelt: A Study In Sustainable Water Management* (http://cooper.edu/isd/news/waterwatch/statenisland). These effort was started in 1990.

[399] The Nature Conservancy, *Urban Coastal Resilience: Valuing Nature's Role*. (2015), https://www.nature.org/content/dam/tnc/nature/en/documents/urban-coastal-resilience.pdf.

[400] "Johnson Creek Restoration, Portland, Oregon," Naturally Resilient Communities, accessed November 12, 2019, http://nrcsolutions.org/johnson-creek-restoration-portland-oregon/.

[401] Exploration Green, 2018, https://www.explorationgreen.org/.

[402] Keri B. Watson, Ricketts T., Galford G., Polasky S., O'Niel-Dunne J., Quantifying flood mitigation services: The economic value of Otter Creek wetlands and floodplains to Middlebury, VT, Ecological Economics, Volume 130: 16-24 (2016), https://doi.org/10.1016/j.ecolecon.2016.05.015.

To assist the Corps in assessing and implementing these types of solutions in the Yazoo Backwater Area, the Conservation Organizations have repeatedly provided the Corps with a proposal for a detailed Resilience Alternative and important information to help guide on-the-ground implementation of the measures included in that Resilience Alternative. The Resilience Alternative is discussed in Section M of these comments.

O. The DEIS Does Not Meaningfully Address Downstream Flood Risks

The DEIS does not meaningfully address the risk that the Yazoo Pumps will increase flooding for vulnerable downstream communities. When operating at full capacity, a 25,000 cfs pump would push more than 16 billion gallons of water a day into the Yazoo River when the river is already at flood stage (when the Steele Bayou flood control gates are closed due to backwater flooding from the Yazoo River), increasing flood risks for highly vulnerable communities downstream, including the Ford Subdivision in North Vicksburg where 93% of residents are Black and 61% of households are low-income. The Ford Subdivision already floods on a regular basis.

The Corps has not properly examined the significant risks of its 25,000 cfs pump on these vulnerable communities downstream. Instead, the Corps has relied on a single 3 sentence email, and the same extremely flawed downstream flood model it used in 2019 to claim that the Yazoo Pumps Alternatives would not increase flood risks downstream.[403]

The Corps asked the Warren County Emergency Management Agency whether all the homes that had flooded in 2011 Mississippi River flood were raised or bought out so that "if a 2011 event were to occur today then none of the homes would be flooded or flooded with people inhabiting those homes." In response, the Director of the Warren County Emergency Management emailed the following reply (this response is quoted in its entirety):

> Yes, that is correct for the most part. We lost most of those files that were done electronically, but we do have some paper files on them, but most were either raised or demolished, same with the backwater losses too. There were some buyouts and those were demolished.[404]

This email does nothing to confirm that operation of the massive 25,000 cfs Yazoo Alternative pumping plants will not increase flood risks downstream.

The 2019 model that the Corps continues to rely on to assess downstream impacts is so flawed that it "cannot be trusted to get a correct answer" as documented in a comprehensive review of that model conducted in 2020 by William Fleenor, Ph.D., an expert with more than 25 years of experience with hydrologic modeling.[405] Dr. Fleenor's report and CV are provided at Attachment J.

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[403] During the May 4, 2023 open house at the Theodore Roosevelt National Wildlife Refuge Visitor Center, a representative from the Corps advised members of the Conservation Organizations that the Corps had reached these conclusions using the same model it used to analyze downstream flood risks in 2020.

[404] Email from Director, Warren County Emergency Management to the Corps dated November 27, 2023 (provided to the Conservation Organizations in response to a Freedom of Information Act Request). A copy of this email is provided at Attachment I to these comments.

[405] William E. Fleenor, Ph.D., Analysis of the HEC-RAS 1D Model Used by the U.S. Army Corps of Engineers in Assessment of their report: "*Impacts of the Yazoo Backwater Pumps to Downstream Stages 22 November 2019*",

Dr. Fleenor's review concludes that the model used by the Corps is fundamentally unreliable and "cannot be trusted to get a correct answer" regarding the impact of the Yazoo Pumps on flood levels in the Yazoo River:

> The U.S. Army Corps of Engineers used a one-dimensional hydrodynamic HEC-RAS model to assess the downstream impacts of the Yazoo Backwater Pumps on water elevations (stage) in the Yazoo River during the peak 2019 event. Review of that Model demonstrates that it is not capable of accurately examining stage changes in the Yazoo River because it provides a poor and very inaccurate representation of the Yazoo River, does not properly match measured stages and flows, uses obviously inappropriate boundary conditions, and is not sufficiently calibrated.
>
> More specifically, the Model represents the lower reach of the Yazoo River (the area most likely to be affected by the Yazoo Pumps) as being 17.5 miles, or 37.5%, longer than it actually measures, and this added length alone disqualifies the Model from being reliable. The Model also includes many cross-sections for the Yazoo River that are wider than justified, which results in the Model producing a Yazoo River that can convey more water than reality. The Model demonstrates extraordinarily little tendency to match the amount of timing of the measured flow in the lower reach of the Yazoo River, with the modeled flows at the USGS Redwood gage location (the closest upstream gage to the proposed location of the Yazoo Pumps) often peaking while flows measured by the Redwood gage are in a trough, and the six-month simulation of the Model producing modeled flow at the Redwood gage with 76.2 billion cubic feet less than measured by that gage. Due to the use of inappropriate flow boundary conditions, the Model predicts stage and flow levels that do not match the levels measured by gages in 2019. The base model performance of stage and flow at Yazoo River gages indicates that the Model was not calibrated and thus cannot be trusted to get a correct answer under any type of changes, such as the additional flows generated by the pumps.
>
> The Model must be more accurately defined, and the boundary conditions better established before the Model can be properly calibrated, and then used to assess the impacts of the Yazoo Backwater Pumps. Use of a two-dimensional model would provide a much better assessment of stage elevations in the primary area of interest due to many of the flows being across the main Yazoo River channel and the crossflow area from the Mississippi River.[406]

In short, as exposed by the Fleenor review, the Corps' model inaccurately assumes that the river is wider and longer and has less water in it than reality—and thus, that the Yazoo River has more capacity to handle the pumps discharge without overflowing its banks than it actually has. As of May 4, 2023, the Corps had not corrected the many flaws documented in Dr. Fleenor's review[407] and the Conservation Organizations have seen no indication that the Corps has corrected this model since that time.

November 1, 2020 at 1. The Corps' HEC-RAS 1D model utilizes both Mississippi River and tributary Yazoo River reaches.

[406] Id.

[407] During the May 4, 2023, open house at the Theodore Roosevelt National Wildlife Refuge Visitor Center, a representative from the Corps advised members of the Conservation Organizations that the Corps had reached these conclusions using the same model it used to analyze downstream flood risks in 2020.

It is critical that the Corps correct the many flaws in its downstream flood model and then use that corrected model to assess the impacts of the Yazoo Pumps Alternatives (and multiple variations of operating a 25,000 cfs pumps): (1) on water level elevations in the Yazoo River; (2) on flood and other risks to downstream communities, including communities in North Vicksburg; (3) on the main access road to Eagle Lake, Highway 465—which is located outside of the YBWA (*i.e.*, on the riverside of the Yazoo Backwater Levee) and would be on the receiving end of the 16 billion gallons of water a day discharged by the Yazoo Pumps; and (4) on water levels in the Mississippi River

P. The Yazoo Pumps Alternatives Do Not Conform to the Federal Flood Risk Management Standard

The Yazoo Pumps Alternatives do not conform to the Federal Flood Risk Management Standard (FFRMS), which was enacted to ensure that federal agencies make sound flood risk and floodplain management decisions, including ensuring that federal flood mitigation projects will be resilient to floods that are larger than a 100-year flood event. This standard ensures a full consideration of risks, changes in climate, and vulnerability; encourages the use of natural features and nature-based approaches in the development of alternatives; and provides a higher vertical elevation and corresponding floodplain, where appropriate, to address current and future flood risks. Compliance with the planning requirements established by the FFRMS is mandatory for all federally funded projects like the Yazoo Pumps.

The Federal Flood Risk Management Standard "requires executive departments and agencies to avoid, to the extent possible, the long- and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct or indirect support of floodplain development wherever there is a practicable alternative."[408]

The Federal Flood Risk Management Standard also sets forth guidelines to ensure a full consideration of risks, changes in climate, and vulnerability; requires stand-alone alternatives that use natural features and nature-based approaches; and provides a higher vertical elevation and corresponding floodplain, where appropriate, to address current and future flood risks.[409] For example:

> If an agency has determined to, or proposes to, conduct, support, or allow an action to be located in a floodplain, the agency **shall** consider alternatives to avoid adverse effects and incompatible development in the floodplain. Where possible, an agency **shall** use natural systems, ecosystem processes, and nature-based approaches when developing alternatives for consideration.[410]

The Federal Flood Risk Management Standard also requires that flood risk reduction studies use one of the following three approaches for defining the relevant vertical elevations and corresponding floodplain:

[408] E.O. 13690, Section 1. E.O. 11988 and E.O. 13690, in combination, establish the Federal Flood Risk Management Standard.
[409] E.O. 11988 and E.O. 13690.
[410] E.O. 11988 Section 2(a)(2).

(1) Climate Informed Science Approach: Under this approach the Corps would use the elevation and flood hazard area[411] that result from using the best-available, actionable hydrologic and hydraulic data and methods that integrate current and future changes in flooding based on climate science;

(2) Freeboard Value Approach: Under this approach the Corps would use elevation and flood hazard area that results from adding an additional 2-feet to the base flood elevation for non-critical actions and by adding an additional 3-feet to the base flood elevation for critical actions; or

(3) The 500-year floodplain approach: Under this approach the Corps would use the elevation and flood hazard area that is subject to flooding by the 0.2 percent annual chance flood.[412]

The Yazoo Pumps Alternatives do not conform to the FFRMS. Among other problems, the Yazoo Pumps Alternatives do not avoid the long- and short-term adverse impacts associated with the occupancy and modification of floodplains despite the existence of highly effective and practicable alternatives that would allow the Corps to do so. The Yazoo Pumps Alternatives also do not address current and future flood risk within the Yazoo Backwater Area and cannot make Yazoo Backwater Area communities resilient to floods that are larger than a 100-year flood event because the since the Yazoo Pumps Alternatives are only designed to provide relief to certain types of flood events, cannot provide relief during a 100-year flood event because doing so could result in overtopping the Yazoo Backwater Levee which came close to overtopping during the 2019 flood event and is specifically designed to overtop during a 100-year event to help protect Vicksburg.

The DEIS also does not consider the planning requirements established by the FFRMS. For example, the DEIS has not demonstrated that: (1) the Yazoo Pumps Alternatives avoid highly significant adverse impacts to floodplain functions; (2) the Corps can restore and preserve the significant floodplain functions that would be lost to the Yazoo Pumps Alternatives; (3) the Corps adequately considered natural and nature-based solution alternatives; and (4) the Corps meaningfully considered and addressed the increased flood risks to downstream communities resulting from the discharge of 16 billion gallons of water a day into the Yazoo River when it is already at flood stage.

The Corps also appears to have focused its entire plan on reducing impacts to non-food crops within the 5-year floodplain. Our organizations highlight that the FFRMS highlights that "certain agricultural uses and practices in the floodplain may adversely affect natural floodplain values" and notes that these constitute a type of incompatible floodplain development.[413]

Cotton, corn, and soy crops are notoriously resource intensive, polluting, and under standard farming operations would further erode natural floodplain values, which would be in conflict with the FFRMS that the Corps is required to follow. The Corps has not provided any evidence that agricultural producers in the Yazoo Backwater adhere to conservation practices that would be considered to not adversely affect natural floodplain values. Examples of such conservation practices would include flood-

[411] "Flood hazard area" describes the area of land subject to flooding during a 1 percent annual chance of exceedance event. Thus, the Climate Informed Science Approach can be applied where climate-informed models indicate deviations from the 1 percent ACE as defined by the currently adopted Flood Insurance Rate Map.
[412] https://www.fema.gov/floodplain-management/intergovernmental/federal-flood-risk-management-standard.
[413] FEMA Guidelines for Implementing E.O. 11988 and E.O. 13690 at 72.

tolerant crops, low-impact husbandry, and regenerative agricultural practices. This is yet another reason why the Yazoo Pumps Alternatives encourage incompatible floodplain development.

To ensure compliance with the FFRMS, the Conservation Organizations once again urge the Corps to implement the suite of measures outlined in the Resilience Alternative which is discussed in detail in Section M of these comments.

Q. The DEIS Does Not Assess Project Costs and Benefits

For decades the cost of the Yazoo Pumps has never been justified by the prospective benefits. The economic costs of the Yazoo Pumps Alternatives have grown exponentially given the significantly larger size of these pumps and the power costs needed to operate the pumps. At the same time, the DEIS makes unfounded assertions that the pumps are essential to providing flood protection, and new employment opportunities in the farm service sector, for historically disadvantaged households and communities. This "environmental justice" argument has contributed to a DEIS that ignores traditional economic justifications for the pump while offering no evidence or explanation as to how the Yazoo Pumps Alternatives could conceivably be justified on environmental justice grounds.

The DEIS should have prepared and evaluated alternatives, including the Resilience Alternative, that would result in the agricultural sector remaining productive and profitable with farmers continuing, as they do now, to benefit from USDA programs of price support and crop insurance, while offering landowners the opportunity to enroll in the Wetland Reserve Program. As part of this approach, the Corps could maintain and increase ecosystem services in the area by implementing promised but not yet completed mitigation and taking advantage of Federal programs and private market opportunities for wetlands afforestation. This approach offers a multi- agency environmental justice alternative to comprehensively and cost-effectively reduce areas subject to flooding, mitigate flood risk and upgrade housing stock at individual properties, creating certain and meaningful employment for the areas disadvantaged households. Such an alternative would be fiscally responsible by releasing some of the Corps' limited budget to address flood resiliency in other parts of the nation.

To help advance this solution, and to fully assess the Yazoo Pumps Alternatives, the DEIS must—but does not—fundamentally reexamine the s economic costs and benefits of the Yazoo Pumps Alternatives. This reexamination is essential in light of the new data, changed conditions, cost increases, significantly larger pumps, and required power source, among other things. This fundamental reevaluation is also critical given the many deficiencies in the last such assessment, which was based on 2005 price levels.[414]

The DEIS must also ensure that the same criteria used to assess the geographic extent of wetland impacts (i.e., the new period of record and new flood frequency elevations referred to in the Notice of Intent and DEIS) is also used to assess the geographic extent of flood damage reduction benefits. The DEIS must also ensure that the benefit-cost analysis documents and fully accounts for the costs if all elements required to construct, operate, maintain, and mitigate the adverse impacts of the Yazoo Pumps Alternatives.

[414] This analysis was included in the 2007 FSEIS.

Based on our estimates, constructing a 25,000 cfs pumping plant would cost well over $1.4 billion.[415]—which under the existing authorization would be fully funded by the federal taxpayers, with no local cost share. It will cost substantially more to construct all the other elements required to operate and maintain what would be the world's largest hydraulic pumping plant (including for example, constructing an energy source for these massive pumps). The mitigation that would be required for this plan would add significantly more to the project's enormous price tag.

The Corps' cost estimate must also account for the economic realities facing the Corps today, including the Congressionally recognized fact that the "**Corps has seen bids on important navigation and flood control projects come in at double or triple the previous cost estimates**."[416]

The DEIS must also account for the inevitable—and potentially extremely significant—cost increases that will occur over time. For example, the Inland Waterways Journal reports that the most recent estimate of costs for the: (i) Kentucky Lock Replacement Project had "ballooned" by $332 million; (ii) Chickamauga Lock project had increased by $197.5 million or 26%; and (iii) Phase 2 of the Three Rivers project had increased by $76 million.[417]

Significant cost increases are not a new phenomenon. For example, older cost estimate information shows that the:

- American Rivers Common Features, CA increased by **at least 1,863%** (original estimated cost of $57 million increased to $1.2 billion, in part due to the need to make significant design changes to ensure public safety[418]).
- Pump component of the Larose to Golden Meadow project, LA increased by **at least 1,238%** (original estimated cost of $800,000 increased to $10.7 million, due to design changes required to handle the actual site conditions[419]).
- Olmstead Lock and Dam project, IL and KY increased by **at least 277%** (original estimated cost of $775 million increased to $2.9 billion, due in part to unaccounted for construction challenges[420]).
- Turkey Creek Basin project, KS and MO increased by **at least 152%** (original estimated cost of $43 million increased to $108 million, including $10 million increase for major work required to access the construction site[421]).

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[415] The West Closure Complex in New Orleans is currently the world's largest pump station, with a pumping capacity of 19,000 cfs powered by 5,000 horsepower diesel engines. The West Closure Complex cost $1.1 billion in 2014. New Orleans Times Picayune, The West Closure Complex: How it works (updated July 18, 2019); NOLA.com, Photos: Largest pump station in the world, located 30 minutes from New Orleans, gets ready for hurricane season (May 12, 2022). Accounting for just minimal inflation, it would now cost more than $1.4 billion to build this smaller, 19,000 cfs pumping plant. Under the existing authorization, the entire cost of the pumps would be borne entirely by federal taxpayers, with no local cost share.

[416] House Committee Report, FY23 E&W Appropriations Bill at 7 (https://docs.house.gov/meetings/AP/AP00/20230622/116151/HMKP-118-AP00-20230622-SD003.pdf) (emphasis added).

[417] Waterways Journal Editorial, What's Going On With Project Cost Increases?, July 27, 2023 (available at https://www.waterwaysjournal.net/2023/07/27/whats-going-on-with-project-cost-increases/).

[418] https://usace.contentdm.oclc.org/digital/collection/p16021coll6/id/2194/rec/1.

[419] GAO-14-35 Flood Control Cost Overruns at 15.

[420] https://www.lrl.usace.army.mil/Portals/64/docs/Projects/FactSheets/Olmsted.pdf?ver=2020-02-27-101155-187.

[421] GAO-14-35 Flood Control Cost Overruns at Appendix III.

- Roanoke River Upper Basin project, VA increased by **at least 113%** (original estimated cost of $29 million increased to $61.7 million, due to required redesign to address the discovery of hazardous waste sites[422]);
- Monongahela Locks & Dam project, PA increased by **at least 102%** (original estimated cost of $556 million increased to $1.1 billion[423]).

The Corps must then compare these costs to the project's purported benefits. In assessing benefits, the Corps must, among other things, pay careful attention to the elevations of acreage and structures being evaluated for benefits and the length of time it would take the pumps to draw water from those acres or structures under different flood scenarios. The Corps also must ensure that it does not count rate relief under the National Flood Insurance Program as a project benefit because the Yazoo Pumps Alternatives would not meaningfully reduce flood risks to communities.

Importantly, the Corps must ensure that it does **not** calculate benefits on any of the 250,000-plus acres of conservation lands in the Yazoo Backwater Area—lands that are being managed precisely for their wetland values. The Corps also must ensure that it does **not** calculate benefits on any of the 19,463-plus acres of flooding and flowage easements owned by the Corps in the Yazoo Backwater Area or on mitigation lands owned by the Corps or others in the Yazoo Backwater Area.[424] To the contrary, draining or degrading wetlands on any of these lands must be accounted for as project cost, which can be at least partially quantified through an assessment of ecosystem services lost on these lands due to the Yazoo Pumps Alternatives.

Finally, the Corps must ensure that the benefits of any separable elements of the project, such as altering the operation of the Steele Bayou gates, are not used to economically justify the proposed 25,000 cfs pumping plant and its related infrastructure. Benefits resulting from mitigation activities also cannot be used to justify the proposed pumping plant and related infrastructure, as mitigation is designed to offset lost values.

1. Costs of Construction, Operations, Maintenance, and Mitigation

The DEIS should develop and document a completely new estimate of project costs, including mitigation costs. Cost estimates developed for the 2007 study should not be relied on in any way given the many changes that have occurred since then. The 2007 study's cost estimates were based on 2005 price levels.

Project costs should include the costs of constructing and operating all components of the Yazoo Pumps Alternatives both inside and outside of the Yazoo Backwater Area, including the pumping plant, inlet and outlet channels, stream channel modifications, power generating facilities, transmission lines, temporary and permanent road construction, staging areas, fuel costs, and the costs of any other types of activities that would be carried out during project construction, operation, and maintenance over the life of the project.

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[422] GAO-14-35 Flood Control Cost Overruns at Appendix III.

[423] https://www.lrp.usace.army.mil/Portals/72/docs/Mission/Planning%20Program%20Project%20Management/2021-116LowermonWEBOverviewPage(April2021).pdf.

[424] U.S. Army Corps of Engineers Response to August 12, 2003 Freedom of Information Act Request for Flowage Easement Data Submitted by American Rivers.

Project costs should also include the quantified value of the ecosystem services that will be lost to the Yazoo Pumps Alternatives, as required by the March 2013 Principles and Requirements for Federal Investments in Water Resources and the December 2014 Interagency Guidelines that implement those Principles and Requirements (collectively, the PR&G). The PR&G apply to Corps projects, and the Corps is in the process of developing agency specific guidelines to ensure full implementation.

The March 2013 Principles and Requirements state that evaluation methods "should apply an ecosystem services approach in order to appropriately capture all effects (economic, environmental and social) associated with a potential Federal water resources investment." The December 2014 Interagency Guidelines state that "Federal investment impacts on the environment or ecosystem may be understood in terms of changes in service flows. The process of identifying, evaluating, and comparing these changes provides a useful organizing framework to produce a complete accounting. **Reduced service flows over time amount to costs, and increased services flows over time amount to benefits**." The Guidelines also state: "Agencies must provide an explicit list of the services that flow from the existing study area ecosystems and infrastructure (including operational plans) with identification of those services that are likely to meaningfully change within the larger context of the watershed because of the Federal investment."

2. Flood Damage Reduction Benefits—Agriculture

The 2007 SEIS determined that more than 80% of the alleged benefits from the Yazoo Pumps would come from increased agricultural production—which makes it clear that agricultural drainage is the project's true primary purpose. Draining wetlands to promote increased agricultural production is an archaic concept from another era and is in direct conflict with current federal law and policy.

The economic analysis in the Corps' 2007 FSEIS reported a BCR that "barely justified" the cost for what was, at the time that estimate was prepared, a $207 million project. As noted above, agricultural benefits accounted for more than 80% of the project's alleged benefits. However, as the Corps is aware, an extensive and independent economic review of the Corps' analysis exposed many extensive flaws in the Corps' 2007 economic assessment. That report, prepared by Leonard Shabman and Laura Zepp (the "Shabman Report") in cooperation with EPA,[425] also determined that the Yazoo Pumps would do nothing more than "**help landowners grow crops on land that is farmed only to earn farm subsidy payments**"[426] and that the significantly less costly derivation of the Yazoo Pumps considered in the 2007 EIS could not be economically justified.[427]

To justify construction of the Yazoo Pumps Alternatives as the NED plan (which continues to be required because the agency specific procedures for implementing the PR&G have not been finalized), the Corps would need to demonstrate that the present value of the NED agricultural benefits, which dominated the Corps' 2007 NED justification for the pumps, have increased enough to offset: (i) the net present value of the significant construction costs of the proposed 25,000 cfs pumps; and (ii) the significant

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[425] Leonard Shabman & Laura Zepp Review Comments on "Yazoo Backwater Reformulation" dated September 24, 2000; *see also* Leonard Shabman & Laura Zepp, An Approach for Evaluating Nonstructural Actions with Application to the Yazoo River (Mississippi) Backwater Area (February 7, 2000) (prepared in cooperation with the U.S. Environmental Protection Agency, Region 4). Both of these documents were submitted with the Environmental Protection Agency Comments on the 2007 Draft SEIS.
[426] Id.
[427] 2007 FSEIS, Main Report at S-2. This report projected a benefit-cost ratio of 1.5.

reduction in agricultural acres available to benefit from operation of the Yazoo Pumps Alternatives due to significant acres of croplands having been transitioned to conservation lands and forest production since the 2007 EIS.

However, nothing has changed in the Yazoo Backwater Area's agricultural economy, in the broader agricultural economy, in the watershed, or in the basic logic of the pump formulation that could justify a finding that the net present value of agricultural benefits could have grown enough since the 2007 FSEIS analysis to exceed the net present value of the $1.4+ billion costs to construct the 25,000 cfs pumps. For example:

(1) The costs of production in Mississippi relative to inflation have increased since the Corps prepared the economic analysis it used in the 2007 report, reducing net returns per acre in each year.[428]

(2) Prices for crops grown in the Yazoo Backwater Area, relative to general inflation, have not increased, reducing net returns per acre. For example:

National-level normalized price estimates for commodities for 2017–22 USDA Economic Research Service[429]						
Commodity	Report year 2017	Report year 2018	Report year 2019	Report year 2020	Report year 2021	Report year 2022
Wheat, all types (bushels)	6.55	5.88	5.27	4.93	4.65	4.68
Corn, for grain (bushels)	4.98	4.40	3.70	3.53	3.50	3.68
Cotton, lint, upland (pounds)	0.72	0.68	0.67	0.66	0.66	0.67
Cottonseed (tons)	235.80	222.80	200.80	182.60	176.00	169.40
Soybeans, for beans (bushels)	11.79	11.18	10.17	9.27	8.96	9.33

(3) Crop yields have not grown at the significant rate that would be necessary to offset the effects on NED of fewer acres, lower prices and higher costs. To offset these effects on NED, the difference in crop yields and changes in crop patterns on lands made "flood-free" by the Yazoo Pumps Alternatives would need to grow much more significantly than the already significant increases in growth projected in the 2007 FSEIS economic analysis. If the trends in prices and costs between 2002 and 2022 are used to extrapolate future prices and costs, those trends

[428] The Conservation Organizations have been advised that adjusting the costs for inflation since 2002, will not reflect the actual costs for soybeans in Mississippi which have increased by 2.36 since 2002.
[429] USDA Economic Research Service, Normalized Prices (available at https://www.ers.usda.gov/data-products/normalized-prices/).

would not warrant a claim of significant increases in net returns on the flood prone land made less flood prone by the pumps.[430]

Given the many flaws in the analysis used by the Corps in the 2007 FSEIS, it is essential that the DEIS conduct a fundamentally new and comprehensive assessment of agricultural benefits. This new economic analysis also must be fully evaluated by, and be consistent with, the recommendations provided by both internal and independent external peer reviews.

Notably, the Corps may not rely on plan elements unrelated to the pumping plant to economically justify agricultural benefits because those elements are unquestionably separable elements that are unrelated to agricultural production. This would include such things as changes in the operation of the Steele Bayou flood control gates (which can be done immediately and is completely unrelated to the proposed pumping plant), and nonstructural or nature-based elements, and of course anything related to mitigation which is intended to offset adverse impacts and thus, does not create a benefit.

The new economic analysis must carefully assess and account for at least the following:

(1) A full assessment of farm ownership in the areas of the Yazoo Backwater Area that would be able to intensify agricultural production due to operation of the Yazoo Pumps, to ensure that the concentration of benefits warrants the large investment of federal taxpayer dollars that would be required to construct and operate the Pumps. The 2007 FSEIS noted that there were only 192 farms in the project area with an average size of 2,913 acres.[431] The 2007 FSEIS did not provide farm ownership information, so it is was not possible to discern whether some landowners or corporations own multiple farms in the project area. As discussed in Section N.1 of these comments, the limited number of farms, and the industrial size of those farms reinforce the fact that the Yazoo Pumps Alternatives prioritize benefits to industrial scale agriculture at the expense of vulnerable Yazoo Backwater Area communities and the environment.

(2) A full assessment of farm subsidy payments in the Yazoo Backwater Area to assess whether additional subsidies to intensify agricultural production are in fact necessary or an appropriate investment of federal taxpayer dollars. As the Corps is aware, an extensive and independent economic review determined that the Yazoo Pumps would do nothing more than "**help landowners grow crops on land that is farmed only to earn farm subsidy payments,**" based on the economic data used by the Corps in the 2007 SEIS.[432] That review also determined that the Yazoo Pumps could not be economically justified even at what was then a $207 million projected construction cost.[433]

(3) A full and accurate accounting of land use and related elevations in the Yazoo Backwater Area.

[430] The Corps' 2007 analysis projected significant increases in net returns over time and it was those projections that made the present value of the net returns greater than project cost. The Shabman Report included multiple critiques on the Corps NED analysis, including critiques of the Corps' very high projected increases in net returns.
[431] 2017 FSEIS Main Report at 24.
[432] Leonard Shabman & Laura Zepp Review Comments on "Yazoo Backwater Reformulation" dated September 24, 2000 (emphasis in original); see also Leonard Shabman & Laura Zepp, An Approach for Evaluating Nonstructural Actions with Application to the Yazoo River (Mississippi) Backwater Area (February 7, 2000) (prepared in cooperation with the U.S. Environmental Protection Agency, Region 4). Both of these documents were submitted with the Environmental Protection Agency Comments on the 2007 Draft SEIS.
[433] Id.

Agricultural benefits must be carefully assessed only on agricultural lands that would see reduced levels of inundation during the growing season sufficient to justify more intensive agricultural practices. No agricultural or other flood damage reduction benefits should be calculated for conservation and easement lands in the Yazoo Backwater Area. No agricultural or other flood damage reduction benefits should be calculated for lands used for mitigation for the Yazoo Pumps or other projects. The value of ecosystem services lost on agricultural (and all other) lands must be accounted for as a project cost.

(4) A full comprehensive assessment of farm elevations in the Yazoo Backwater Area, to ensure that only those farms in areas that could see reduced flood inundation are accounted for in the benefits analysis, and to ensure that no benefits are counted for farms lying below the 91-foot NGVD elevation since the 2008 Clean Water Act veto prohibits pumping below this elevation. The Corps is also prohibited from pumping below the 90-foot NGVD elevation under the current authorization, which designates lands "located below 90 feet, NGVD, in elevation to serve as a sump area for surface water storage."[434] The 2007 FSEIS did not provide any information on the elevation of farms.

(5) A comprehensive assessment of whether the Yazoo Pumps would in fact provide any statistically significant benefit to agricultural production, or would instead harm agricultural production in the Yazoo Backwater Area. A scientific study conducted in the Yazoo River Basin strongly suggests that the Yazoo Pumps would harm—not help—agricultural production in the Yazoo Backwater Area.[435]

This study looked at the riverine hydrological and regional climatic regime relationships to agriculture (cotton, soybeans) and the principal riverine fish stocks in the upper Yazoo River basin. The study looked at 31 years of data (from 1964 to 1994) to compare flooding in the study area with soybean and cotton production. It found that "**no factor associated with flood events adversely influence production of cotton and soybeans**. However, with regard to soybeans, the amount of area flooded two years prior to a crop was positively related to soybean yield. **From a long-term perspective therefore, the data suggest that flooding may benefit agricultural enterprises associated with soybean production**."[436] The study also found that **cotton yield was positively correlated with maximum area flooded during the same year**, noting that this was likely due to increased soil moisture which benefits cotton production. This was true even though floods resulted in fewer acres of cotton being planted during flood years.[437]

The study did note, however, that a different pattern appeared to emerge over shorter time periods "which may explain the public perception that flooding adversely impacts agriculture in the area. During the 5 year period from 1990-1994, high precipitation was negatively related to area planted in cotton and the percent of the area planted in soybeans that was actually

[434] Id.
[435] Jackson, D. C. and Q. Ye. 2000. Riverine fish stock and regional agronomic responses to hydrologic and climatic regimes in the upper Yazoo River basin. Pages 242-257 *in* I. G. Cowx, Editor. Management and Ecology of River Fisheries. Fishing News Books. Blackwell Science. London. This study was submitted into the record for the veto process on May 5, 2008.
[436] Id.(emphasis added).
[437] Id.

harvested. However, flooding during this period did not significantly affect overall yield of cotton and soybeans."[438] And again, there was a positive correlation between cotton yields and the maximum area flooded during the same year.

That same study also shows that flooding benefits fisheries in the area, finding a positive relationship between flooding and positive fish stock characteristics, which the study defines as more and bigger fish. The study also noted that much of the productive potential for fisheries in floodplain river ecosystems is determined by the dynamics of overbank flooding and riparian vegetation.[439]

The ability to plant crops even during years with large flood events. Even during the prolonged 2019 flood event, 316,000 acres of crops were grown in the Yazoo Backwater Area (more than 55% of the 10-year average acreage of crops grown in the Yazoo Backwater Area), according to USDA data.[440] This data would appear to contradict the statement in the NOI that "Farmers lost their entire 2019 crop season in the affected area."[441]

In addition, the Conservation Organizations understand that farmers were eligible to receive disaster relief or other forms of compensation to minimize economic losses due to the inability to plant crops on the Yazoo Backwater Area lands that could not be planted as a result of the 2019 flood event.

In 2008, then Mississippi Governor Haley Barbour stated on Mississippi Public Radio that even during the 100-year flood of 1973, farmers had good soybean crops. Indeed, we understand that many farmers prefer to plant after floods because it is cheaper to do so. Post-flood planting reduces the amount of chemicals that must be applied to the land to clear the fields, and reduces the amount of fertilizer needed due to the nutrients provided by the flooding.

(6) A full assessment of actual crop losses in the areas that could see reduced inundation under the Yazoo Pumps Alternatives, and a full assessment of the amount of any such losses that are uninsured and/or otherwise unsubsidized. Only uninsured losses (less any subsidies) that could be reduced by operation of the Yazoo Pumps should be accounted for in the assessment of project benefits.

3. Flood Damage Reduction Benefits—Homes, Businesses, Structures

In assessing flood damage reduction benefits to homes, businesses, and other structures, the Corps should utilize an up-to-date inventory of all structures and roads in the Yazoo Backwater Area. This inventory must utilize precise elevation data collected through FEMA's approved elevation survey methodology to determine the elevation of the lowest inhabited floor (as opposed to just the elevation of adjacent land). Flood damage reduction benefits for structures and other infrastructure may only be calculated for areas and elevations that would see reduced levels of flood inundation.

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[438] Id.
[439] Id.
[440] USDA National Agricultural Statistics Service, CropScape Cropland Data Layer.
[441] 88 Fed. Reg. at 43102.

The Corps should also ground truth its quantification of flood damage reduction benefits, including by comparing the predicted benefits with the limited, and highly concentrated, structural damage incurred during the 2019 flood.

Before assessing potential flood damage reduction benefits for the Eagle Lake Community, the Corps should conduct a detailed after-action assessment of the cause of the 2019 Eagle Lake area flooding. Factors that likely influenced the 2019 flooding of homes near Eagle Lake include the Lake's water control management regime and actions associated with maintaining the stability of the portion of the Mississippi River mainline levee that abuts Eagle Lake. Deficiencies in the Brunswick Circle Levee, a private levee first built in the 1880s, also likely played a role in the 2019 flooding near Eagle Lake. Brunswick Circle encompasses 4,000 acres of land in the Eagle Lake area, and is home to 230 residents and one church, as reported by the Vicksburg Post. In 2022, the Mississippi Legislature awarded $75,000 to Warren County to pass through to the landowner to address the Brunswick Circle Levee deficiencies.[442] If these factors played a role in the flooding surrounding Eagle Lake, it is likely that the area would have flooded in 2019 even if the Yazoo Pumps were in operation. The multiple risk factors facing Eagle Lake must be accounted for when calculating any flood damage reduction benefits for the Yazoo Pumps.

The discussion of benefits must also account for the fact that all structures in the Yazoo Backwater Area that were substantially destroyed by the devasting tornado that swept through Rolling Fork and Sharkey County on March 24 (at least 300 homes and businesses), that are being rebuilt with the assistance of funding provided by the federal government, must be rebuilt above the 100-year floodplain elevation—far above the 5-year floodplain elevation that is the focus of the Yazoo Pumps Alternatives and at an elevation that is above the flood-level elevation when the pumps can be used. *See* discussions above regarding the inability to use the Yazoo Pumps during a 100-year flood event.

The Corps should also take steps to ensure that it does not overstate potential benefits as it clearly did in the 2007 study. For example, the 2007 FSEIS claims that the average household in the project area has two automobiles valued at $15,000 per car. The Corps says that despite the low velocity flooding typical in the study area that about 1/3 of these cars will get flood damages estimated at $298,000 per year. These estimates make no sense given the economics in the project area. At the time these values were assessed, the average per capita income in Sharkey and Issaquena counties was $11,187, and one third of the population lived below the poverty level. Median household income was approximately $20,000 to $22,000 depending on the county. Based on these economic realities, it is highly unlikely that each home would have two cars valued at $15,000 sitting in the driveway, or that if this were the case, it is even more unlikely that the owners would not simply drive their cars to higher ground during the typical slow-moving flood event.

4. Benefits of Nonstructural, Natural, and Nature-Based Measures

The Corps should account for the value of ecosystem services provided by nonstructural, natural, and nature-based measures (and to account for the losses in ecosystem services resulting from the Yazoo Pumps Alternatives to ensure proper assessment of these approaches. In carrying out these assessments, the Corps should use the many existing well-established ecosystem services valuation tools and studies, including the Duke University, Nicholas Institute report on *Valuing Ecosystem Services from*

[442] Anna Guizerix, Vicksburg Post, Warren County Supervisors to act as pass-through agency for Brunswick Circle Levee funds, August 18, 2022.

Wetland Restoration in the Mississippi Alluvial Valley, and the Earth Economics report *Gaining Ground, Wetlands, Hurricanes, and the Economy: The Value of Restoring the Mississippi River Delta*.

In addition to fully accounting for ecosystem service values, the Corps should also account for the following benefits when evaluating nonstructural, natural, and nature-based measures:

- Avoiding costs of flood-fighting and dislocation borne by federal and state agencies, local municipalities, and the public.

- Avoiding costs to U.S. Department of Agriculture Commodity programs, Federal Crop Insurance, and Noninsured Crop Disaster Assistance programs. A recent study documents these avoidance benefits (present value of avoided costs less Wetland Reserve Easement Program and restoration costs) in Mississippi at $870 per acre. *Wetland Reserve Easement Program Economic Assessment: Estimated Commodity Program and Crop Insurance Premium Subsidy Cost Avoidance Benefits,* prepared for the Nature Conservancy (June 2, 2018) (authored by retired U.S. Department of Agriculture economist Dr. Doug Lawrence).

- National Flood Insurance Program Rate Reductions: Protecting floodplains has the largest impact on lowering National Flood Insurance Program (NFIP) rates for communities participating in the voluntary Community Rating System Program (CRS). Participation in the CRS can reduce NFIP rates from 15% to 45%. The CRS credits over 90 elements of comprehensive floodplain and watershed management, including providing significant credits for protecting the natural functions of riverine floodplains by preserving natural floodplain open space, acquiring flood-prone land and returning it to its natural state, and protecting and restoring natural floodplain functions and habitat.[443]

R. The DEIS Does Not Comply with the Mandatory Independent External Peer Review Requirements

Any new study must be reviewed under the Independent External Peer Review (IEPR) process required by 33 U.S.C. § 2343. IEPR is mandatory for this EIS since the Yazoo Pumps Alternatives and any variation of the Yazoo Pumps will cost well over $200 million and would unquestionably be highly controversial.[444] The Yazoo Pumps Alternatives and any derivation of the Yazoo Pumps will satisfy both of the IEPR controversy triggers as: "there is a significant public dispute as to the size, nature, or effects of the project" and "there is a significant public dispute as to the economic or environmental costs or benefits of the project."[445]

As the Corps is well aware, "in all cases" the IEPR review must be carried out concurrently with the project study and must be completed "**not more than 60 days after the last day of the public comment period for the draft project study**," unless the Chief of Engineers determines that more time is necessary.[446] The Corps provides IEPR plans online, and is required by law to provide the public with

[443] Federal Emergency Management Agency Fact Sheet, The Community Rating System works to Protect Natural Floodplains (2015) (available at https://www.fema.gov/media-library-data/1459276443255-663d02584edc3ac6cda2f4a7f337100b/Natural-Functions-and-CRS.pdf).
[444] 33 U.S.C. § 2343(a).
[445] 33 U.S.C. § 2343 (a)(4).
[446] 33 U.S.C. §§ 2343(b) and 2343(d) (emphasis added).

information on the timing of the IEPR, the entity that has the contract for the IEPR review, and the names and qualifications of the IEPR panel members.[447]

Despite these clear requirements, and repeated requests from the Conservation Organizations do to so, the Corps has not initiated the required IEPR for this project, making it impossible for the Corps to comply with this longstanding requirement in the timeline allowed by law. The Conservation Organizations once again call on the Corps to initiate the required IEPR for this project and urge the Corps to contract with the National Academies to carry out the IEPR to ensure that the review is carried out by fully independent experts with the highest possible qualifications.

S. The Yazoo Pumps Alternatives Would Require New Congressional Authorization

The Yazoo Pumps Alternatives vastly exceed the scope of the project's 1941 Congressional authorization so could not be built unless and until the Corps obtains new Congressional authorization.

The Flood Control Act of 1941 authorized construction of the Yazoo Pumps in accordance with Plan C of the March 7, 1941, Mississippi River Commission Report.[448] Plan C delimits both the capacity of the authorized pumps and the conditions of their use imposing strict limits on the project that can be built by the Corps.

Plan C "assumes that pumps of about 14,000 cubic feet per second capacity would be provided to prevent the sump level from exceeding 90 feet, mean Gulf level, at average intervals of less than 5 years." Plan C also designates lands "located below 90 feet, NGVD, in elevation to serve as a sump area for surface water storage."[449] The limitations established by the Yazoo Pumps authorization are extensively documented in the 2008 Clean Water Act veto.[450]

In 1959, the Corps determined that this authorized level of protection had been met:

> Since the original authorization for Yazoo Backwater Protection, important hydraulic changes have taken place due to improvement of channel efficiency in the Mississippi River and to reservoirs and channel improvement in the Yazoo Basin headwater area. These have resulted in less frequent flooding, and shorter duration of flooding, which makes it feasible to develop a simplification of the authorized plan by eliminating pumping at a large saving in project cost. . . . It is apparent that a protection plan for the Yazoo Backwater Area involving levees and floodgates only, which was not feasible under earlier conditions, is now feasible, and will provide a high degree of protection for the foreseeable future without the necessity of pumping.[451]

The Steele Bayou flood control structure completed in 1969 and the Yazoo Backwater Levee completed

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[447] 33 U.S.C. § 2343.
[448] 1941 Chief of Engineers Report on Flood Control on The Lower Mississippi River (including Plan C), H.R. Doc. No. 359, 77th Congress, 1st Sess. (1941). Plan C had an estimated first cost of Plan C had an estimated first cost of $11,982,000. Id. at 40.
[449] Id.
[450] Clean Water Act 404(c) Final Determination at 7-9.
[451] Id. (quoting Vicksburg District Corps, MR&T Comprehensive Review Report, Annex L, Yazoo Backwater Project Mississippi at 20 (November 1959)).

in 1978 increased that level of protection.[452] Indeed, since the Yazoo Backwater Levee was completed, flooding in the Yazoo Backwater Area has been restricted to the lowest elevations.

Between 1978 and 2018, water levels in the Yazoo Backwater Area **never** reached the 20-year floodplain and exceeded the 10-year floodplain just 2 times.[453] In 2019, flooding in the Yazoo Backwater Area was predominately restricted to the 20-year floodplain—reaching just 0.23 inches above the 25-year floodplain for just 8 days before receding—even as unprecedented flooding inundated communities along the Mississippi, Missouri, and Arkansas Rivers. In 2020, flood levels in the Yazoo Backwater Area rose above the 10-year floodplain elevation for just 5 days in early March (after which levels receded for 38 days) and then again for 15 days in the second half of April.[454] By comparison, flooding in the Yazoo Backwater Area reached 101.48 feet in 1973, which is well above the 100-year floodplain elevation.

The Corps' 2020 Yazoo Pumps FSEIS provides further evidence that the authorized level of flood protection has been met, through its contention that the "new and more complete" period of record (1978-2019) shows that the Holly Bluff cut-off (which was completed in 1958) and the Yazoo Backwater Levee (which was completed in 1978) caused a one to three foot reduction in the 2-year floodplain elevation.[455] As discussed in Section C.1, the Corps' reliance on new flood frequency elevations has the effect of reducing the number of acres categorized as "riverine wetlands" which in turn will result in a showing of fewer wetland impacts because of the Yazoo Pumps Alternatives.

In the face of these significant changes in the extent of flooding and flood frequency elevation levels the DEIS should clearly explain why the Corps believes that the authorized level of flood protection (as set forth in the 1941 project authorization) has not already been achieved.

On their face, the Yazoo Pumps Alternatives vastly exceed the limits imposed by the 1941 Flood Control Act. The Yazoo Pumps Alternatives propose a pumping plant with a vastly larger capacity—**78% larger**—than the authorized (and prohibited) 14,000 cfs pump and would drain water from areas explicitly protected by the 1941 authorization.[456] Under the Yazoo Pumps Alternatives, the pumps would need to be turned on **below the 90-foot-NGVD** elevation during at least 7 months each year (crop season) to keep water from rising above that 90-foot elevation.[457]

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[452] The Corps has not presented any evidence to suggest that the hydrology of the project area has changed so that the authorized level of flood protection is no longer being provided. To the contrary, all the evidence demonstrates that there is significantly less flooding in the Yazoo Backwater Area, and particularly since completion of the Yazoo Backwater Levee in 1978.

[453] Floodplain elevation level source: USACE, Final EIS Yazoo Backwater Pumping Plant, Main Report at 90 (lower ponding area without project in place) Final Supplement No. 1 to the 1982 Yazoo Area Pump Project Final Environmental Impact Statement (2007), Main Report at 90, Table 13 (lower ponding area elevation base conditions); Steele Bayou Landside gage elevation source: USACE, RiverGages.com, http://rivergages.mvr.usace.army.mil.

[454] During these 20 days, water levels peaked at just 0.5 inches (at 96.86 feet) above the 10-year floodplain elevation for a single day before receding. Notably, during in 2020, water levels in the yazoo backwater area were overwhelming restricted to the 1-year, 2-year, and 5-year floodplain elevations (water was in the 5-year floodplain for 46 days).

[455] 2020 FSEIS, Appendix F-5 (Wetlands) at 35-36.

[456] Lands "located below 90 feet, NGVD, in elevation [are] to serve as a sump area for surface water storage." 1941 Chief of Engineers Report on Flood Control On The Lower Mississippi River (including Plan C), H.R. Doc. No. 359, 77th Congress, 1st Sess. (1941).

[457] DEIS, Appendix A engineering Report at 135.

While the Corps has limited ability to approve changes to a project without first obtaining Congressional approval, Corps regulations make clear that doing so in this instance would be an abuse of discretion. Under the Corps' Engineering Regulations, the Chief of Engineers' has discretionary authority to approve changes to authorized projects, but that authority "must not be abused"[458] and the use of that authority requires heightened scrutiny to determine whether certain types of changes will require Congressional authorization. This heightened scrutiny must be applied in situations like the Yazoo Pumps Alternatives, where the scope of any one project parameter would increase by more than 20 percent:

> Increase or decrease in scope no greater than 20 percent of the scope authorized by Congress. If the scope can be defined by several parameters, (for example, storage capacity, outputs, environmental impacts) and the change in any one parameter exceeds 20 percent, the change must be approved by the Commander USACE.[459]

As defined in this regulation, "changes in scope" are:

> increases or decreases in the outputs for the authorized purposes of a project. Outputs are the projects physical effects which (usually) have associated benefits (hence, project purpose). Change in the degree of reduction in flood stages is a change in a project outputs. It would be a change in scope if it resulted from formulation, or from design changes. Changes in the value of outputs (benefits) resulting from price level changes, or from other purely economic phenomena, are not considered changes in scope.[460]

The Yazoo Pumps Alternatives adopt a pumping capacity that is 78% larger than the authorized 14,000 cfs plan—which is clearly much greater than a 20% change in a project output. The physical effects of this significantly larger pumping plant also may well exceed the physical effects on wetlands and/or flood stages of the authorized project by more than 20%, causing significantly more ecological harm than the Congressionally authorized project.

Congress would need to authorize construction of the Yazoo Pumps Alternatives before the Corps could legally construct the project. Any such authorization would be subject to the standard cost share requirements applicable to flood damage reduction projects built by the Corps.[461]

Conclusion

Every previous iteration of the Yazoo Pumps has been rejected. In 1958, the Corps' Chief of Engineers recommended a plan without the Yazoo Pumps. In 1959, the Chief of Engineers concluded that Yazoo Pumps were not needed because the authorized level of flood protection had already been provided by other projects. In 1986, the non-federal sponsor chose not to proceed with the project in light of the newly established non-federal cost share requirement. In 1991, the Office of Management and Budget rejected another Yazoo Pumps study, directing a fundamental reevaluation of the project that that fully considers "predominately nonstructural and nontraditional measures." In 2008, the George W. Bush Administration EPA stopped the project by issuing just the 12th Clean Water Act 404(c) veto in history,

[458] ER 1105-2-100, Appendix G, Amendment #1 (30 Jun 2004) at G-56.
[459] Id.
[460] Id. at G-55.
[461] 33 U.S.C. § 2213.

with strong support from the Department of the Interior. In late 2021, the Biden Administration EPA stopped yet another attempt to build the Yazoo Pumps by reasserting the 2008 Clean Water Act veto.

The Conservation Organizations call on the Corps to follow suit and abandon the destructive and dangerous Yazoo Pumps Alternatives. The Yazoo Pumps Alternatives, like all derivations of the Yazoo Pumps before it, would cause unacceptable harm to hemispherically significant wetlands to increase profits for highly subsidized agricultural producers. The Yazoo Pumps Alternatives would increase flood risks for highly vulnerable communities downstream without providing meaningful protection to vulnerable communities in the Yazoo Backwater Area. Instead of continuing to push the unacceptable and vetoed Yazoo Pumps, the Corps and other federal agencies should support deployment of highly effective non-structural, natural, and nature-based flood risk reduction solutions as requested by many local community leaders and the conservation community.

Thank you for your careful consideration of our request and of the extensive supporting documentation that we have provided. Please contact Melissa Samet (National Wildlife Federation, sametm@nwf.org, 415-762-8264) or Jill Mastrototaro (Audubon Delta, Jill.Mastrototaro@audubon.org, 504-481-3659) if you have any questions or would like additional information.

Sincerely,

Melissa Samet
Legal Director, Water Resources and Coasts
National Wildlife Federation

Brian Moore
Vice-President, Coast Policy
National Audubon Society

/s *Athan Manuel*

Athan Manuel
Director of Lands Protection Program
Sierra Club

Jill Mastrototaro
Mississippi Policy Director
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Louie Miller
State Director
Mississippi Chapter of the Sierra Club

Andrew Whitehurst
Water Program Director
Healthy Gulf

Attachments

From: Melissa Samet <sametm@nwf.org>
Sent: Tuesday, August 27, 2024 6:24 PM
To: YazooBackwater MVK
Subject: [Non-DoD Source] Conservation Organization Yazoo Pumps Comments: Email 2 of 4
Attachments: Conservation Organization Comments_Yazoo Pumps DEIS_Attachments A, B, C, D, E.pdf

Importance: High

Please see attachments A, B, C, D, and E to the comments on the Yazoo Pumps Draft EIS from the National Wildlife Federation, National Audubon Society, Sierra Club, Audubon Delta, Healthy Gulf, and Mississippi Chapter of the Sierra Club.

Due to the large file size of the attachments, I am sending the text of the comments and the Attachments in 4 separate emails. This is email 2 of 4.

I would very much appreciate you confirming receipt of each of the 4 emails.

Thank you.

Melissa Samet
Legal Director, Water Resources and Coasts
National Wildlife Federation
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(c) 415-577-9193
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Attachment A

Comments on the Draft Environmental Impact Statement for the
Yazoo Backwater Area Water Management Project, June 2024

Submitted by

National Wildlife Federation, National Audubon Society, Sierra Club
Audubon Delta, Healthy Gulf, Sierra Club Mississippi

August 27, 2024

Nonstructural, Natural and Nature-Based Solutions for the Yazoo Backwater Area

The conservation community recommends implementation of a Resilience Alternative that implements effective non-structural, natural, and nature-based flood risk management solutions for the Yazoo Backwater Area through existing federal programs. The Resilience Alternative uses a whole of government approach to deliver lasting, meaningful relief to underserved Yazoo Backwater communities while addressing long-standing environmental injustices and protecting the region's hemispherically important wetlands. Importantly, the Resilience Alternative features numerous elements (e.g., FEMA Building Resilient Infrastructure and Communities and Flood Mitigation Assistance programs) that support and advance the Biden Administration's environmental justice priorities, including the Justice40 Initiative and Executive Order 14008 "Tackling the Climate Crisis at Home and Abroad".

This Resilience Alternative has been shared with your agencies on many occasions and was included in the binders handed out during the February 16, 2023 stakeholder meeting. We provide additional information for prioritizing the Resilience Alternative solutions below:

1. **Reestablish natural flood protection by restoring and protecting wetlands in the YBWA.** It is well-known that healthy wetlands make communities safer and more resilient, including by absorbing floodwaters and giving rivers room to spread out without harming homes and businesses. As the Corps has long-recognized:

   > "Nature has already provided the least-cost solution to future flooding in the form of extensive [riverine] wetlands which moderate extreme highs and lows in streamflow. Rather than attempt to improve on this natural protection mechanism, it is both prudent and economical to leave the hydrologic regime established over millennia undisturbed."[1]

   Restoring wetlands in the YBWA will avoid unintended adverse impacts from the Yazoo Pumps, including diverting floodwaters onto other highly vulnerable communities. Restoring and protecting healthy wetlands in the YBWA will also provide vital wildlife habitat for hundreds of fish and wildlife species and many millions of migratory birds and waterfowl; improve water quality, including by reducing nutrient runoff into the Yazoo and Mississippi Rivers; sequester carbon[2]; and reduce federal farm subsidy payments.[3]

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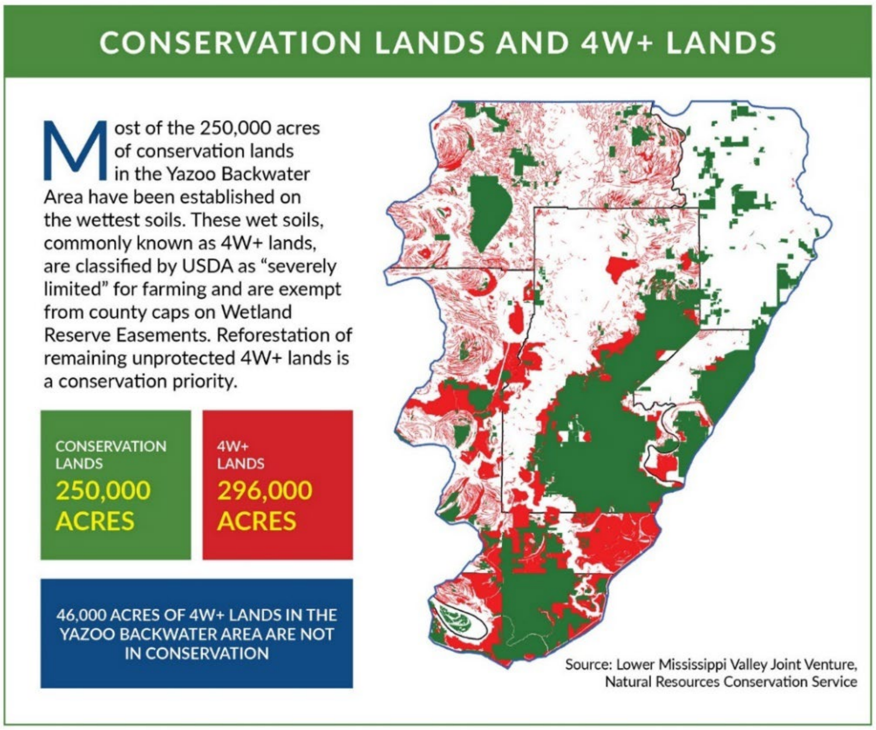
[1] American Rivers, Unnatural Disasters, Natural Solutions: Lessons From The Flooding Of New Orleans (2006) (quoting USACE, from Massachusetts Department of Fish and Game, *Functions of Riparian Areas for Flood Control*, http://www.mass.gov/dfwele/river/pdf/riparian_factsheet_1.pdf.)

[2] Wildlife Mississippi, The Carbon for the Trees: Carbon Sequestration in Forests of the Mississippi Alluvial Valley, August 2019, prepared for the Walton Family Foundation at 10 (citing the Conservation Fund) ("Each tree planted in the MAV absorbs approximately 1 ton of carbon dioxide over its lifetime. The typical reforestation project in the MAV involves planting 302 trees per acre."); Shoch, David T., G. Kaster, A. Hohl, R. Souter, Carbon Storage of Bottomland Hardwood Afforestation in the Lower Mississippi Valley USA, Wetlands, 2009 (concluding that one acre of bottomland hardwood forest in the Mississippi Alluvial Valley can remove and store the equivalent of 328 metric tons of CO_2 over 100 years).

[3] Previously cropped lands enrolled in a WRE create economic benefits by reducing costs in commodity, Federal crop insurance, and Noninsured Crop Disaster Assistance programs. In Mississippi, farm program payment cost avoidance benefits (present value of avoided costs less the Wetlands Reserve easement and restoration costs) exceed the costs associated with WRE acquisition and wetland restoration, according to a recent study by a retired U.S. Department of Agriculture economist. Specifically, the research showed cost avoidance benefits of $870.08

To advance these solutions, the ***U.S. Department of Agriculture*** should prioritize the enrollment of at least 80,000 acres of Yazoo Backwater Area (YBWA) lands in the agency's Wetland Reserve Easement (WRE) and Floodplain Easement Programs. **Wetland Reserve Easements** should be targeted towards marginal croplands (those with 4W+ soils) adjacent to existing conservation lands, croplands inundated during the 2019 floods, croplands within the acquisition boundaries established for the National Wildlife Refuges in the YBWA, and croplands targeted for restoration by the Lower Mississippi Valley Joint Venture. The USDA has classified 46,000 acres of the unprotected lands in the YBWA as having 4W+ soils, which are "severely limited" for agriculture because they are saturated at least 50% or more during the growing season. There is **significant interest** in enrolling more lands in WRE within the YBWA, and there are no county or other caps limiting the acreage of marginal croplands with 4W+ soils that can be enrolled in WRE in this area.



Floodplain Easements should first be targeted towards frequently flooded residential properties. Residential properties and cropland are both eligible for enrollment in the ***Department of Agriculture's*** Floodplain Easement program.

The ***U.S. Fish and Wildlife Service*** should prioritize purchase and restoration of croplands within the approved 34,682 acquisition boundaries for the National Wildlife Refuges in the YBWA, including the approved 24,600 acres of acquisition approved for the Theodore Roosevelt National Wildlife Refuge Complex and Holt Collier National Wildlife Refuge.[4] Funding for land acquisition (including via

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per acre in Mississippi. *Wetland Reserve Easement Program Economic Assessment: Estimated Commodity Program and Crop Insurance Premium Subsidy Cost Avoidance Benefits, 2018, prepared for the Nature Conservancy, at 45.*
[4] U.S. Fish and Wildlife Service, Theodore Roosevelt and Holt Collier National Wildlife Refuges Comprehensive Conservation Plan, October 2015 at 3, 40; U.S. Fish and Wildlife Service, Theodore Roosevelt National Wildlife

easements) would come from the Land and Water Conservation Fund; the Migratory Bird Conservation Fund; U.S. Army Corps of Engineers' mitigation programs; or donations from conservation and private organizations.

2. **Implement pre-disaster mitigation planning and protection actions in the YBWA.** These actions will reduce the risk of damage from future high water events, improve community safety, increase community resilience, minimize flood disaster disruptions, and allow more rapid recovery when flooding does occur. To advance these solutions, the ***Federal Emergency Management Agency*** should prioritize pre-disaster mitigation funds and assistance to YBWA communities. On average, $1 spent on hazard mitigation through a federally funded mitigation grant saves $6 in future disaster costs. Federal grants provide $7 in benefits for each $1 invested in riverine flood mitigation.

3. **Elevate low-lying road segments subject to repeated flooding in the YBWA.** Targeted road elevations can help ensure that YBWA residents can access homes, businesses, and essential services during flood events. This work can be carried out through targeted use of ***Department of Transportation*** and other applicable programs and funding. Elevations could be prioritized for the following low-lying road segments that flooded during the 2019 flood, according to the Mississippi Levee Board:

Road	Elevation of Flooded Segment	Elevation of Floodplain 2007 EIS NGVD[5]
Blanton Road	92.0 feet	Below 5-year floodplain *(elevation 94.6 feet NGVD)*
Spanish Fort Road	92.5 feet	Below 5-year floodplain *(elevation 94.6 feet NGVD)*
Goose Lake Road	93.4 feet	Below 5-year floodplain *(elevation 94.6 feet NGVD)*
Low Water Bridge Road	93.7 feet	Below 5-year floodplain *(elevation 94.6 feet NGVD)*
Highway 16 Delta National Forest segment Between Rolling Fork and Holly Bluff	96.0 feet	Below 10-year floodplain *(elevation 96.3 feet NGVD)*
Satartia Road Segment East of Holly Bluff	None provided	

Refuge Complex Hillside, Mathews Brake, Morgan Brake, Panther Swamp, and Yazoo National Wildlife Refuges, February 2006 at 109.

[5] According to the 2007 EIS at page 6-44, the 5-year floodplain elevation is 94.6 feet NGVD and the 10-year floodplain elevation is 96.3 feet NGVD. The 2020 EIS (Table 5.3) provides different elevation numbers, but does not provide the datum used to calculate these elevations. The 2020 SEIS also appears to apply data from three different datums as though they are equivalent, when they in fact are not. For example, the DSEIS variously states that pumps would turn on at 87.0 feet (NGVD29), at 87.0 feet (NAVD88), and when water levels reach 87.0-feet Mean Sea Level (MSL). SEIS, Appendix G (Engineering). The modern standard elevation unit, used by the Corps' National Levee Database and the FEMA Flood Insurance Rate Maps, is 1988 North American Vertical Datum (NAVD88). Older elevation data is typically based on the 1929 National Geodetic Vertical Datum (NGVD29). In the YBWA region, most NAVD88 elevations are between 0.0 inches and 7.87 inches below the NGVD29 elevations, on average and require conversion. NOAA National Geodedic Survey (accessed November 18, 2020). In some locations in North America these different elevation baselines can deviate by as much as 30 feet.

4. **Ensure delivery of post-disaster recovery assistance and funds to the YBWA.** Effective use of post-disaster recovery funds to the YBWA would improve community resilience and reduce future flood risks. The ***Federal Emergency Management Agency***, ***U.S. Department of Agriculture***, and ***U.S. Department of Housing and Urban Development*** should ensure that the programs under their jurisdictions prioritize delivery of post-disaster recovery assistance and funding to the YBWA. As a first step, post-disaster recovery funds should fund elevations and/or voluntary buy-outs of "severe repetitive loss" and "repetitive loss" properties in the YBWA, and improve essential community infrastructure. The ***Federal Emergency Management Agency*** has identified 198 severe repetitive loss properties in Issaquena and Sharkey counties (which are located entirely within the YBWA).[6] To our knowledge, the YBWA has received little to no post-disaster recovery assistance or funding from the federal government since 2016, despite suffering through five federally-declared Major Disasters and two federally-declared Emergency Declarations during that time.[7]

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[6] Of these severe repetitive loss properties, 150 are in Issaquena county and 48 are in Sharkey county. An additional 1,191 severe repetitive loss properties are located in Warren, Washington, and Humphreys counties, but large portions of these counties (and thus, many of these properties) are located outside the YBWA.

[7] Mississippi Hurricane Ida (DR-4626-MS); Mississippi Hurricane Delta (EM-3548-MS); Mississippi Severe Storms, Flooding, and Mudslides (DR-4538-MS); Mississippi Severe Storms, Straight-line Winds, Tornadoes, and Flooding (DR-4429-MS); Mississippi Severe Storms and Flooding (DR-4268-MS); Mississippi Covid-19 Pandemic (DR-4528-MS); Mississippi Covid-19 (EM-3474-MS).

Yazoo Backwater Area
A Resilience Alternative

Strategic use of voluntary wetland reserve easements, restoration, and non-structural measures can reduce flood risks for vulnerable communities in the Yazoo Backwater Area (YBWA) of Mississippi, make those communities and the nation's wildlife more resilient to climate change, and advance the vitally important 30x30 Initiative by permanently protecting 80,000 acres of critical wetlands. These commonsense measures could be implemented through existing federal programs under the direction of an interagency task force convened by the Council on Environmental Quality and led by the U.S. Fish and Wildlife Service, U.S. Department of Agriculture, and Federal Emergency Management Agency.

The hemispherically significant wetlands in the YBWA are "some of the richest wetland and aquatic resources in the nation."[1] They support 450 species of birds, fish and wildlife; are used by 29 million migrating birds each year; and include tens of thousands of acres of federal, state, and privately-owned conservation lands. Critically, these wetlands help protect YBWA communities by storing hundreds of billions of gallons of floodwaters, improving water quality, and sequestering carbon. To prevent unacceptable damage to more than 67,000 acres of these vital wetlands, the Environmental Protection Agency used its Clean Water Act 404(c) authority in 2008 to veto the Yazoo Pumps. This veto paved the way for the subsequent protection of an additional 53,300 acres of YBWA wetlands through conservation easements and other voluntary mechanisms.

But in a reckless about-face and in direct violation of the law, the Trump Administration hastily revoked the 2008 veto and then approved the Yazoo Pumps just days before President Biden was sworn in to office. The Corps refused to consider this Resilience Alternative—or any other alternative to the destructive and ineffective Yazoo Pumps—despite repeated requests to do so. The Corps' decision was opposed by the U.S. Fish and Wildlife Service, 110 scientific professionals, four scientific associations, 120 conservation and social justice organizations, and more than 55,000 members of the public.

The $450 million Yazoo Pumps will drain tens of thousands of acres of wetlands to subsidize large-scale agribusiness operations that have already received $1.05 billion in farm subsidies.[2] The Yazoo Pumps are <u>not</u> designed to protect communities and will <u>not</u> prevent flooding.[3] The Pumps will leave 82% to 89% of flooded lands underwater, take weeks to months to drawdown floodwaters on the remaining lands, and increase flood risks for downstream frontline communities.[4]

The Biden Administration can deliver immediate, sustainable flood relief to underserved communities in the YBWA while protecting nationally significant wildlife resources by reconfirming EPA's 2008 veto of the Yazoo Pumps, withdrawing the fatally flawed Record of Decision approving the project, and appointing an interagency task force to implement the Resilience Alternative outlined below.

Targeted Use of Existing Federal Programs in the Yazoo Backwater Area

Flooding in the YBWA is primarily restricted to conservation lands managed as wetland systems, low-lying marginal agricultural lands targeted for restoration by the Lower Mississippi Valley Joint Venture, and other low-lying, sparsely populated areas.[5] Strategic implementation of existing federal programs can protect communities in the YBWA, while also achieving the area's critical restoration goals.

The programs outlined below authorize and fund the voluntary wetland reserve easements, restoration, and non-structural measures that are part of this Resilience Alternative. Strategic use of these measures can be achieved through an interagency task force led by the U.S. Fish and Wildlife Service, U.S. Department of Agriculture, and Federal Emergency Management Agency.

Federal Program	Structures	Agricultural Lands	Community Facilities	Roads, Bridges Utility Systems
Wetland Reserve Easements (WRE) **USDA**		✓		
Floodplain Easement Program **USDA**	✓	✓		
Building Resilient Infrastructure and Communities (BRIC) **FEMA – Pre-Disaster Mitigation**	✓		✓*	✓
Flood Mitigation Assistance (FMA) **FEMA – Pre-Disaster Mitigation**	✓		✓*	✓
Hazard Mitigation Grant Program (HMGP) **FEMA – Post-Disaster Recovery**	✓		✓	✓
Community Facilities Grant Program **USDA – Post-Disaster Recovery**	✓		✓	

*With some limitations. Other federal programs, including the HUD Community Development Block Grants-Disaster Recovery Program, are also available to assist with post-disaster recovery subject to targeted appropriations.

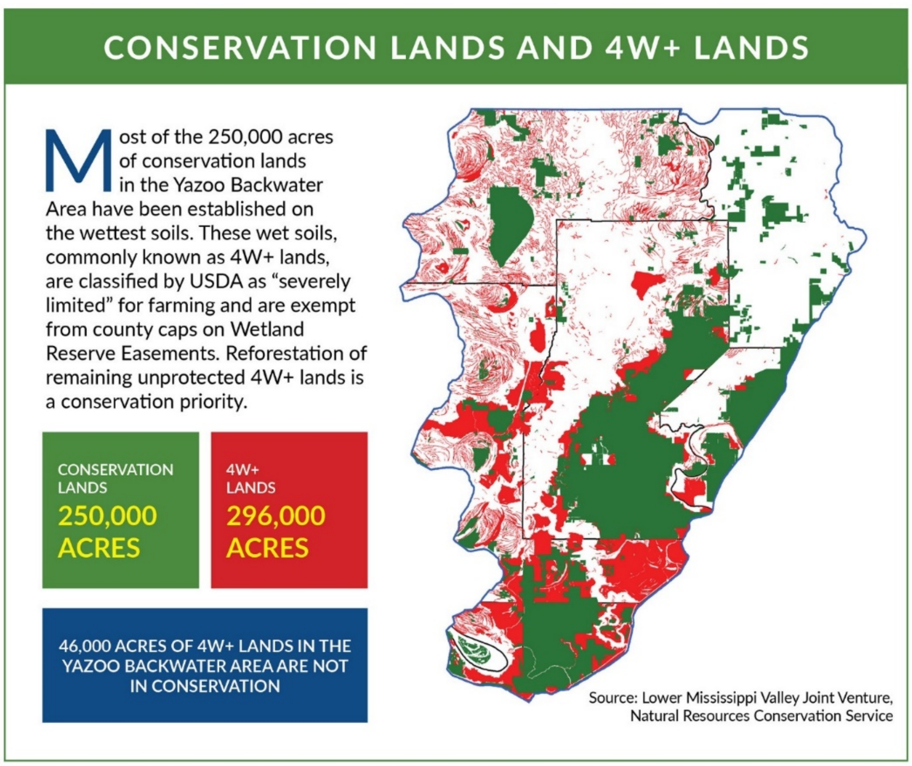
The benefits of these measures could be amplified by an innovative marketing campaign to stimulate wildlife and cultural heritage-associated tourism in the YBWA developed in collaboration with the Mississippi Delta National Heritage Area, the Delta Blues Trail, the Delta National Forest, and the Theodore Roosevelt National Wildlife Refuge Complex. The Delta Interpretive Center, which will be housed in the newly constructed Theodore Roosevelt Wildlife Refuge Visitor Center, could be a centerpiece of this effort.[6] Funding for such a campaign could be sought through the Mississippi Delta National Heritage Area Grant Program.[7]

Diversifying the economy of the YBWA in this manner would provide a substantial lifeline to the region's struggling economy. Outdoor recreation in Mississippi generates $8 billion in consumer spending, $620 million in state and local tax revenue, and 79,000 jobs.[8] In 2011, state residents and nonresidents spent $2.63 billion on wildlife recreation in Mississippi.[9] The demand for wildlife-related recreation is increasing nationwide and directing more of this demand to the YBWA could produce significant economic benefits for the region's rural, low income communities.

1. Wetland Reserve and Floodplain Easement Programs (USDA)

Goal: Enroll at least **80,000 acres** of YBWA lands in the Wetland Reserve Easement (WRE) and Floodplain Easement Programs managed by the U.S. Department of Agriculture. These easements should be targeted towards marginal croplands (those with 4W+ soils) adjacent to existing conservation lands, croplands inundated during the 2019 floods, croplands within the acquisition boundaries established for the National Wildlife Refuges in the YBWA, and croplands targeted for restoration by the Lower Mississippi Valley Joint Venture. Floodplain easements should also target frequently flooded residential properties.

This goal is supported by extensive planning assessments, GIS analyses, and the best available conservation science which have been used to identify 80,000 acres of conservation and reforestation priorities for the YBWA. The USDA has classified 46,000 acres of unprotected lands in the YBWA as 4W+ lands, which means they are "severely limited" for agriculture because they are saturated at least 50% or more of the growing season. These 4W+ lands, most of which are adjacent to existing conservation lands, are a priority for WRE enrollment and are exempt from WRE enrollment and county wide caps.



The Lower Mississippi Alluvial Valley Joint Venture has identified 60,000 acres (which includes 20,000 acres of the unprotected 4W+ lands described above) as priorities for restoration and protection to benefit wetland forest breeding birds (e.g. Prothonotary Warbler, Wood Thrush, Wood Duck, Wild Turkey, Swallow-tailed Kite). Restoring and protecting bottomland hardwood forests also benefits other forest-dependent wildlife, including Louisiana Black Bear, at-risk bat species, and the swamp rabbit.

Prothonotary Warblers rely heavily on the Yazoo Backwater Area during spring migration.
Photo: Gary Robinette/Audubon Photography Awards

Responsible Federal Agency and Partners: U.S. Department of Agriculture (Natural Resources Conservation Service) working with landowners, homeowners, communities, and non-governmental organizations.

Funding: Both programs are funded and regularly accept proposals for enrollment.

Multiple Benefits: Restoring enrolled lands to healthy wetlands would provide multiple benefits.

- **Reducing Flood Risks:** Restoring enrolled lands would provide significant flood damage reduction benefits, reduce emergency response costs, and help create safer and healthier communities. A single acre of wetland can store 1.5 million gallons of floodwater,[10] preventing flood damages. For example, wetlands prevented $625 million in flood damages in the 12 coastal states affected by Hurricane Sandy, and reduced damages by 20% to 30% in the four states with the greatest wetland coverage.[11] In its flood damage reduction recommendation for the Charles River in Massachusetts, the Corps of Engineers concluded that: "Nature has already provided the least-cost solution to future flooding in the form of extensive [riverine] wetlands which moderate extreme highs and lows in streamflow. Rather than attempt to improve on this natural protection mechanism, it is both prudent and economical to leave the hydrologic regime established over millennia undisturbed."[12]

- **Improving Water Quality and Groundwater Recharge:** Restoring enrolled lands will help purify water supplies, reduce nutrient loading into streams and rivers, and recharge groundwater in the YBWA. Irrigation in the Mississippi Delta, including the YBWA, has caused some of the most severe groundwater declines in the United States and highly damaging low-flow conditions in many Delta streams. Recent studies demonstrate the significant value of wetlands to groundwater recharge in the YBWA.[13]

- **Providing Vital Wildlife Habitat:** Restoring enrolled lands will provide essential benefits to fish and wildlife in the YBWA and beyond. Wetlands are some of the most biologically productive natural ecosystems in the world, and support an incredibly diverse and extensive array of fish and wildlife. The wetlands in the YBWA support 450 species of birds, fish and wildlife and are used by 29 million migrating birds each year. The YBWA contains one of the last existing and most substantial tracts of highly productive bottomland hardwood forests in the Lower Mississippi River Alluvial Valley, and the U.S. Fish and Wildlife Service has determined that the YBWA is the area with the "greatest potential" for meeting breeding bird habitat restoration and protection needs within the Mississippi Alluvial Valley.[14] Restoring wetlands in the YBWA is a conservation priority for the Lower Mississippi Valley Joint Venture. An additional 1.73 million acres of sustainable forest habitat are needed in the Mississippi Alluvial Valley to attain population goals for most forest-dependent bird species in the region.[15]

- **Sequestering Carbon:** The Mississippi Alluvial Valley was an early proving ground for carbon sequestration through forest restoration and protection. In the 1990's public utilities provided millions of dollars to voluntarily offset their carbon emissions by expanding carbon sequestration on private lands and federal wildlife refuges. There is now renewed interest in facilitating, funding and expanding carbon sequestration incentives on private land in the region.

- **Creating Jobs and Economic Activity:** Restoration work associated with easement enrollment would create jobs. In Mississippi, the Fish and Wildlife Service Partners for Wildlife Program created 29.7 jobs for each million dollars spent on restoration, and $1.63 of economic activity for each dollar spent on restoration in FY2011.[16]

- **Reducing National Flood Insurance Program Rates:** Protecting floodplains has the largest impact on lowering National Flood Insurance Program (NFIP) rates for communities participating in the voluntary Community Rating System Program (CRS). Participation in the CRS can reduce NFIP rates from 15% to 45%. The CRS credits over 90 elements of comprehensive floodplain and watershed management, including significant credits for preserving natural floodplain open space, acquiring flood-prone land and returning it to its natural state, and protecting and restoring natural floodplain functions and habitat.

- **Avoiding Farm Subsidy Costs:** Enrolling cropped wetlands in Wetland Reserve Easements reduces the costs of commodity, federal crop insurance, and noninsured crop disaster assistance programs. A recent study documents these avoidance benefits (present value of avoided costs less the Wetlands Reserve easement and restoration costs) in Mississippi at $870 per acre.[17]

Program Details—Wetland Reserve Easements:

- Cropped and forested lands can be enrolled in the Wetland Reserve Easement Program (WRE) . Enrolled lands are taken out of agricultural production and restored to wetlands.
- Enrollment provides direct payments to landowners, currently up to $3,100 per acre.[18] USDA also pays to restore the enrolled lands. Landowners can make additional profits by selling or leasing the land for hunting, fishing, or other uses compatible with maintaining the restoration. Landowners may also be eligible for a tax deduction.
- Lands classified by USDA as 4W+ are "severely limited" for agriculture because they are saturated at least 50% or more of the growing season. The 2014 Farm Bill exempted 4W+ lands from WRE enrollment and county-wide caps. At least 46,000 acres of 4W+ lands in the YBWA are not in conservation, with many of these acres adjacent to existing conservation lands.
- The WRE program is extremely popular in Mississippi. At least 186,000 acres—including almost 80,000 acres in the YBWA counties—have already been enrolled in the WRE program in

Mississippi (in both the Wetlands Reserve Program and WRE programs which are now combined), according to the NRCS.

Program Details—Floodplain Easements:

- Both cropland and residential properties may be enrolled in the USDA Floodplain Easement program. Cropped lands are taken out of agricultural production and restored. Structures located within the area of a floodplain easement are demolished and removed, or relocated outside of the affected floodplain, and the lands are then restored.
- Enrollment provides direct payments to landowners, currently up to $3,100 per acre.[19] USDA pays to restore the enrolled lands. USDA also pays the costs of demolishing and removing, or relocating structures out of the affected floodplain. Landowners can make additional profits by selling or leasing the land for hunting, fishing, or other uses compatible with maintaining the restoration. Landowners may also be eligible for a tax deduction.

2. Pre-Disaster Mitigation Programs (FEMA)

Goal: Significantly expand pre-disaster mitigation planning and protection in the YBWA to reduce the risk of damage from future high water events and increase community resilience.

Responsible Federal Agency and Partners: Federal Emergency Management Agency working with the State of Mississippi and local governments.

Funding: FEMA's Building Resilient Infrastructure and Communities (BRIC) Grant Program and Flood Mitigation Assistance Program are well funded and accept proposals yearly. FEMA can provide free Flood Risk Management Workshops for elected officials and community administrators to assist communities in reducing flood risks and increasing resilience.

Benefits: Significant public benefits through creation of safer communities by improving resilience, eliminating impacts of future flood events, and providing long-term solutions to flooding problems. Effective pre-disaster mitigation reduces loss of life and property damage from future floods, minimizes flood disaster disruptions, and allows more rapid recovery when flooding does occur. On average, $1 spent on hazard mitigation through a federally funded mitigation grant saves $6 in future disaster costs. Federal grants provide $7 in benefits for each $1 invested in riverine flood mitigation.

Program Details—FEMA BRIC Program:

- The BRIC Program provides funding to states, tribes, and local communities to reduce overall risk to the population and structures from future hazard events and increase community resilience through funding hazard mitigation projects and activities.
- The BRIC priorities are to incentivize: public infrastructure projects; projects that mitigate risk to one or more lifelines; projects that incorporate nature-based solutions; and adoption and enforcement of modern building codes.
- The BRIC program typically covers up to 75% of eligible activity costs, but "small impoverished communities" are eligible for coverage of up to 90% of eligible costs. A small impoverished community is an economically disadvantaged community with 3,000 or fewer individuals having an average per capita annual income not exceeding 80% of the national per capita income.
- The BRIC program is funded through a 6% equivalency set-aside of all disaster expenditures from the Disaster Relief Fund. The BRIC program was funded at $500 million in FY20.

Program Details—FEMA Flood Mitigation Assistance Program:

- The Flood Mitigation Assistance (FMA) Program provides funding to states, tribes, and local governments to reduce or eliminate the risk of repetitive flood damage to buildings and structures insured under the National Flood Insurance Program. FMA funding may cover up to 100% of costs to address severe repetitive loss properties and up to 90% of costs to address repetitive loss properties. Other activities will be funded up to 75%.
- The FMA program was funded at $200 million in FY20.

Program Details—Floodplain Management Training:

- FEMA can provide free Flood Risk Management Workshops for elected officials and community administrators to assist communities in reducing flood risks and increasing resilience. Trainings include information on the National Flood Insurance Program, including its history, standards, regulations and administration; floodplain mapping; flood hazard mitigation; and floodplain management for environmental benefits. FEMA can also provide additional relevant trainings in the YBWA through its Integrated Emergency Management Course.

- The Association of State Floodplain Managers (ASFPM) offers a Certified Floodplain Management program for public and private sector professionals that compliments the FEMA floodplain management trainings. Anyone can join ASFPM and take the CFM exam for a nominal fee. ASFPM members and Certified Floodplain Managers© have access to unique resources that can help their communities more effectively administer FEMA programs, reduce flood insurance rates, and minimize flood damages.

3. Post-Disaster Recovery Programs (FEMA, USDA, HUD)

Goal: Prioritize disaster recovery funds to voluntary buy-outs and elevations of "severe repetitive loss" and "repetitive loss" properties in the YBWA, and improve essential community infrastructure.[20] FEMA has identified 198 severe repetitive loss properties in Issaquena and Sharkey counties (which are located entirely within the YBWA).[21]

Responsible Federal Agencies and Partners: Federal Emergency Management Agency, U.S. Department of Agriculture, U.S. Department of Housing and Urban Development (depending on program used), working with the State of Mississippi, local governments, property owners, and residents.

Funding: The FEMA Hazard Mitigation Grant Program is funded and accepts applications from state and local governments in areas covered by a Presidential disaster declaration. The USDA Community Facilities Grant Program is funded and accepts applications from rural communities with up to 20,000 residents in areas covered by a Presidential disaster declaration. Supplemental appropriations targeted to the YBWA would be required to take advantage of the HUD Community Development Block Grants – Disaster Recovery program and the HUD Community Development Block Grants – Mitigation program.

Benefits: Significant public benefits, including reducing flood risks and emergency response costs, creating safer and healthier communities, and restoring vital floodplain habitat. Increasing the resilience of roads and other community infrastructure improves community well-being and supports economic development. Homeowners are compensated for moving out of harm's way or elevating homes and other structures to avoid future flood damages. Targeting buy-outs to the YBWA would help refocus the HMGP program, which historically has disproportionately funded buy-outs in white communities rather than communities of color.

Program Details—FEMA Hazard Mitigation Grant Program:

- The FEMA Hazard Mitigation Grant Program (HMGP) provides grants to state and local governments in areas covered by a Presidential disaster declaration. FEMA accepts HMGP applications for **one year** after a federal disaster declaration with the possibility of up to a 180-day extension at the state's request. Approximately 70% of FEMA buy-out projects are approved within two years of the associated disaster.
- HMGP grants can be used to purchase flood-damaged properties from willing sellers at pre-flood values and preserve the land as open space, or to elevate structures.
- Any structure in the 100-year floodplain (*i.e*., a Special Flood Hazard Area) valued at up to $276,000 automatically qualifies for a FEMA-funded buy-out, and any structure in a Special Hazard Area valued at up to $175,000 automatically qualifies for a FEMA-funded elevation. Other structures may also qualify if the buy-out or elevation would be cost-effective.
- The YBWA was eligible for HMGP grants through the April 23, 2019 Federal Disaster Declaration 4429 (as amended), which made FEMA's HMGP available to the entire state of Mississippi. Extending this Disaster Declaration would ensure that funding is available for the HMGP program in the YBWA, and any future applicable disaster declaration would re-trigger the availability of post-disaster recovery funds and programs to the YBWA.
- FEMA has funded **638 buy-outs in Mississippi, including 105 in Warren County**, since the 1980s. In all, FEMA has funded the buy-out of more than 43,360 properties through 3,839 "projects" in 49 states. Of these properties, 96% suffered from river flooding or intense rains, while 4% suffered from coastal flooding. The HMGP has funded 96% of all FEMA buy-outs.
- Targeting buy-outs to the YBWA would help refocus the HMGP program, which historically has disproportionately funded buy-outs in white communities rather than communities of color, according to a 2019 NPR investigation. For example, after the 2008 floods in Iowa, "households in high social vulnerability areas were less likely to obtain full financial compensation" from federally funded buyout programs and waited longer to receive acquisition funds.

Program Details—USDA Community Facilities Grant Program:

- The USDA Community Facilities Grant Program provides grants to rural communities with up to 20,000 residents in areas covered by a Presidential disaster declaration. Funding under this grant program can be used to advance more than 100 types of projects, including the purchase, construction, or improvement of essential community facilities. Essential community facilities include such things as health care facilities, town halls, courthouses, community centers, fairgrounds, police and fire departments, libraries, museums, and food banks.
- The 2019 Additional Supplemental Appropriations for Disaster Relief Act appropriated $150 million for grants under this program in areas where FEMA provided a notice declaring a Major Disaster Declaration, which includes the YBWA.

Program Details—HUD Community Development Block Grants – Disaster Recovery:

- The HUD Community Development Block Grants-Disaster Recovery Program (CDBG-DR) supplements FEMA disaster recovery funds to help cities, counties, and states recover from Presidentially-declared disasters, especially in low-income communities. Activities funded through these flexible grants must meet one of three national objectives: benefit low-and-moderate-income persons; aid in the prevention or elimination of slums or blight; or meet other

community development needs having a particular urgency because existing conditions pose a serious and immediate threat to the health or welfare of the community where other financial resources are not available to meet such needs.
- Significant funding can be obtained through the CDBG-DR grant process. For example, Mississippi is currently finishing up two CDBG-DR grants for Hurricane Katrina recovery ($5.06 billion and $423 million) and a third CDBG-DR grant for the 2008 storms ($11.7 million).

Program Details—HUD Community Development Block Grants – Mitigation:

- HUD Community Development Block Grants—Mitigation (CDBG-MIT) may be provided to CDBG-DR grant recipients to "carry out strategic and high-impact activities to mitigate disaster risks and reduce future losses" including by supporting data-informed investments in high-impact mitigation projects; building state and local government capacity for comprehensively analyzing disaster risks; supporting adoption of policies that minimize future disaster costs; and maximizing the impact of funds by leveraging other funding sources.
- Congress appropriated $12 billion in CDBG funds in February 2018 for mitigation activities related to qualifying disasters in 2015-2017, and HUD has allocated an additional $3.9 billion, bringing the amount available for mitigation to nearly $16 billion.

Targeting these available and funded programs to the YBWA would provide immediate, cost-effective, and sustainable flood relief to underserved communities in the YBWA while protecting nationally significant wildlife resources.

Endnotes

[1] U.S. Environmental Protection Agency, Final Determination of The U.S. Environmental Protection Agency's Assistant Administrator for Water Pursuant to Section 404(C) of the Clean Water Act Concerning the Proposed Yazoo Backwater Area Pumps Project, Issaquena County, Mississippi (August 31, 2008).

[2] USDA data compiled through the Environmental Working Group Farm Subsidy Database, shows that farms in the 16 zip codes that fall within the YBWA received a total of $1.05 billion in farm subsidy payments between 1995 and 2019, with the top 5 recipients receiving a total of $20.5 million, $17.4 million, $15.5 million, $14.2 million, and $10.7 million, respectively. The top 5 recipients in each zip code received a total of $430.7 million—an average of $215,000 for each of 80 recipients every year for 25 years—while 272 recipients received more than $1 million each for an average of $40,000 a year for each recipient every year for 25 years.

[3] Operation of the Yazoo Pumps would put downstream frontline communities on the receiving end of an additional 9 billion gallons of water a day when the Yazoo River is already at flood stage. Communities in the Yazoo Backwater Area could flood if that massive influx of water overtopped or damaged the Yazoo Backwater Levee, which is at risk of crevassing and is so low that it is not accredited to handle a 100-year flood. Collapse of this levee would flood the very communities the pumps are purported to protect.

[4] 2020 Final Supplement No. 2 To The 1982 Yazoo Area Pump Project Final Environmental Impact Statement (FSEIS), Appendix C (Tables), Table 5.3 (the "sloped pool" model is the most accurate).

[5] Since completion of the Yazoo Backwater Levee in 1978, there has been a significant decline in the elevation of backwater floods, with water levels in the YBWA reaching the 20-year floodplain elevation just one time—during the unprecedented flood of 2019. From 1978 to 2018, water levels in the YBWA reached the 10-year floodplain just 2 times. By comparison, in 1973 flooding in the YBWA reached 101.48 feet, which is well above the 100 year floodplain elevation. U.S. Army Corps of Engineers Rivergages Website.

[6] The Theodore Roosevelt Wildlife Refuge Visitor Center is "one of the most significant investments in tourism infrastructure" in the Delta.

[7] The Mississippi Delta National Heritage Area, which includes all the YBWA counties, was established by Section 8008 of the Omnibus Federal Land Management Act of 2009, Pub. L. 111–11 (16 USC 461 note) to preserve and

promote the landscape, culture and history of the Mississippi Delta. Section 8008 authorizes appropriations of up to $1 million a year through 2024, and establishes a management authority and a local coordinating entity to assist in developing recreational and educational opportunities in the Heritage Area and increasing public awareness of, and appreciation for, natural, historic, scenic, and cultural resources of the Heritage Area.

[8] Outdoor Industry Association, Economic Value of Recreation in Mississippi 2017 (https://outdoorindustry.org/wp-content/uploads/2017/07/OIA_RecEcoState_MS.pdf).

[9] U.S. Fish and Wildlife Service, 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, State Overview, Table 3.

[10] Environmental Protection Agency, "Wetlands: Protecting Life and Property from Flooding." EPA 843-F-06-001. (2006) (factsheet).

[11] Narayan, S., Beck, M.B., Wilson, P., et al., The Value of Coastal Wetlands for Flood Damage Reduction in the Northeastern USA. Scientific Reports 7, Article number 9463 (2017), doi:10.1038/s41598-017-09269-z (available at https://www.nature.com/articles/s41598-017-09269-z).

[12] American Rivers, Unnatural Disasters, Natural Solutions: Lessons From The Flooding Of New Orleans (2006) (quoting USACE, from Massachusetts Department of Fish and Game, *Functions of Riparian Areas for Flood Control*, http://www.mass.gov/dfwele/river/pdf/riparian_factsheet_1.pdf.)

[13] Ying Ouyanga, et al., Estimating impact of forest land on groundwater recharge in a humid subtropical watershed of the Lower Mississippi River Alluvial Valley, Journal of Hydrology: Regional Studies 26 (2019) 100631 (wetlands in the lower Yazoo River Basin provide the highest rates of groundwater recharge while agricultural lands provide the lowest rates); Michael Gratzer, et al., Quantifying Recharge to the Mississippi River, Valley Alluvial Aquifer from Oxbow Lake-Wetland Systems, (2017) (oxbow lake wetlands near Belzoni, MS produce "significant vertical recharge" into the Mississippi River Valley Alluvial Aquifer).

[14] U.S. Fish and Wildlife Service, Fish and Wildlife Coordination Act Report (October 23, 2006), 2007 Final SEIS, Appendix 3 at 7.

[15] Elliott, A.B.; Mini, A.E.; McKnight, S.K.; Twedt, D.J. Conservation–Protection of Forests for Wildlife in the Mississippi Alluvial Valley. *Forests* 2020, *11*, 75 (available at https://www.mdpi.com/1999-4907/11/1/75).

[16] U.S. Fish and Wildlife Service, The Contribution of Partners for Fish and Wildlife Program and Coastal Program Restoration Projects to Local U.S. Economies (September 2013) at 18.

[17] Wetland Reserve Easement Program Economic Assessment: Estimated Commodity Program and Crop Insurance Premium Subsidy Cost Avoidance Benefits, Prepared for the Nature Conservancy (June 2, 2018) (authored by retired U.S. Department of Agriculture economist Dr. Doug Lawrence).

[18] In Mississippi, payments for enrolling lands in the WRE and Floodplain Easement Programs are the same. Easement purchase prices on forested land are slightly less than on cropland. The payment schedule is established by USDA on a yearly basis and may fluctuate slightly from year to year.

[19] Id.

[20] "Severe repetitive loss properties" are properties covered by the National Flood Insurance Program (NFIP) that have been the subject of four or more damage claims of more than $5,000 each, or two or more claims in which the insured structure sustained cumulative damage exceeding its fair market value. These structures, which are mostly homes, are priorities for elevation or removal. "Repetitive loss properties" are properties covered by the NFIP that have flood-related damage on two occasions where the cost of the repair equaled or exceeded 25% of the market value of the structure at the time of each such flood event; and the second incidence of flood-related damage increased the cost of flood-insurance compliance coverage.

[21] Of these severe repetitive loss properties, 150 are in Issaquena county and 48 are in Sharkey county. An additional 1,191 severe repetitive loss properties are located in Warren, Washington, and Humphreys counties, but large portions of these counties (and thus, many of these properties) are located outside the YBWA.

Attachment B

Comments on the Draft Environmental Impact Statement for the Yazoo Backwater Area Water Management Project, June 2024

Submitted by

National Wildlife Federation, National Audubon Society, Sierra Club
Audubon Delta, Healthy Gulf, Sierra Club Mississippi

August 27, 2024

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August 16, 2024

The Honorable Michael S. Regan
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue NW
Washington, D.C. 20004

RE: Yazoo River Backwater Pumps 2008 Clean Water Act Section 404(c) Final Determination; 2024 Draft Environmental Impact Statement

Dear Administrator Regan:

The Environmental Protection Network (EPN) is an organization of over 650 U.S. Environmental Protection Agency (EPA) alumni volunteering their time to protect the integrity of EPA, public health, and the environment. EPN harnesses the expertise of former EPA career staff and confirmation-level appointees from Democratic and Republican administrations to provide the unique perspective of former regulators with decades of historical knowledge and subject matter expertise. Several of our volunteers were actively involved in the development of the 2008 Section 404(c) Final Determination for the Yazoo River Backwater Pumps[1] and helped write this letter.

On June 28, 2024, the Army Corps of Engineers (ACOE) issued a draft Environmental Impact Statement (EIS) that includes a modified plan to address flooding in the Yazoo Backwater Area. This plan (the 2024 proposed plan) includes large pumps adjacent to the Steele Bayou structure to remove water from the backwater area that could potentially drain and impact up to 97,000 acres of wetlands, including wetlands identified in the 2008 Clean Water Act (CWA) Section 404(c) Final Determination (2008 Final Determination). The 2024 proposed plan includes a proposal to fully develop a pump operating regime, limited proposed mitigation, and limited structural alternatives. The 2024 proposed plan has the same or similar impacts as the plan that was identified and prohibited in the 2008 Final Determination. It also has similar impacts as the 2020 proposed plan which EPA later found were also prohibited under the 2008 Final Determination. As discussed below, consistent with our position in 2020, EPN is focused on the fact that the 2024 proposed plan is prohibited by the 2008 Final Determination. In addition, if ACOE would like to seek to modify the 2008 Final Determination, it has not taken the appropriate steps.

<u>Background</u>

In 2008, EPA issued a Final Determination under Section 404(c) of the CWA withdrawing the specification of the proposed project site for the discharge of dredged and/or fill material for the construction of the project. EPA determined that "the construction and operation of the proposed pumps would dramatically alter the timing, and reduce the spatial extent, depth, frequency, and duration of time that wetlands within the project area are inundated." Furthermore, "these large-scale hydrologic alterations would significantly

[1] Final Determination of the U.S. Environmental Protection Agency's Assistant Administrator for Water Pursuant to Section 404(c) of the Clean Water Act Concerning the Proposed Yazoo Backwater Area Pumps Project Issaquena County, Mississippi. August 31, 2008. https://www.epa.gov/sites/default/files/2015-05/documents/yazoo-final-determination_signed_8-31-08.pdf

degrade the critical ecological functions provided by approximately 67,000 acres of wetlands in the Yazoo Backwater Area, including those functions that support wildlife and fisheries resources."[2] These impacts were not tied to the particular footprint/precise location of the proposed pump but rather to their operation and purpose.

Significant portions of the area that would have been impacted are currently in national wildlife refuges, national forest lands, lands enrolled in federal conservation programs, and state-owned conservation lands. In addition, some of the lands have been purchased and restored using taxpayer funds as mitigation for previously constructed federal water projects.

The implementing regulations for Section 404(c) of the CWA, 40 CFR Part 231, set out a very specific and mandatory process to issue Section 404(c) Final Determinations. During the 2008 Section 404(c) process, EPA met with local stakeholders, held a formal public hearing, issued and published draft and recommended determinations that allowed for public comment, and responded to all comments made and/or submitted related to the project. This process allowed for a full vetting of all the relevant issues, including the environmental impacts of the project as well as environmental justice concerns.

The scope of the 2008 EPA Section 404(c) review included all the alternatives presented by ACOE in the National Environmental Policy Act (NEPA) documents that supported the project, including Plans 3, 4, 5, 6, 7, and a modified Plan 6. During its review and in the Final Determination, EPA found all six of the plans resulted in unacceptable adverse effects to wetlands and fish and wildlife resources (including spawning and breeding areas), the trigger for action under Section 404(c). Ultimately, in 2008, ACOE chose Plan 5 as the Least Environmentally Damaging Practicable Alternative (LEPDA), which became the subject of the Section 404(c) Final Determination.

On January 15, 2021, ACOE published its Record of Decision (ROD) for the Yazoo Area Pumps Project. The ROD was based on the Final Supplemental EIS No. 2, which was finalized on December 11, 2020, with a 45-day public comment period. On November 30, 2020, the then Regional Administrator for EPA Region 4 concluded that the proposed project was *not* prohibited by EPA's 2008 Final Determination.[3] This conclusion was challenged in court and resulted in a remand from the court back to EPA for reconsideration.

EPN submitted comments[4] on October 15, 2021, noting that EPN believed the Regional Administrator at that time erroneously concluded that the proposed 2020-21 pump project was not covered by the 2008 Final Determination. The decision had been made without the opportunity for public input and importantly did not follow precedent for modifying a CWA Section 404(c) Final Determination. As a result, many of the issues the public commented on and the EPA reviewed as part of the 2008 Final

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[2] Final Determination of the U.S. Environmental Protection Agency's Assistant Administrator for Water Pursuant to Section 404(c) of the Clean Water Act Concerning the Proposed Yazoo Backwater Area Pumps Project Issaquena County, Mississippi. August 31, 2008. page i.

[3] November 30, 2020 letter from Mary S. Walker, Regional Administrator, EPA Region 4, to Colonel Robert A. Hilliard, U.S. Army Corps of Engineers, Vicksburg District.

[4] https://www.environmentalprotectionnetwork.org/wp-content/uploads/2021/10/EPN-Letter-on-Yazoo-404c-permit.pdf

Determination, including an analysis of the environmental justice issues, were not fully discussed nor was there full opportunity for public input on this highly significant federal action.

Subsequently, on November 17, 2021, EPA issued a letter to ACOE, finding that the 2020-21 proposed plan was prohibited by the 2008 Section 404(c) Determination. This led to numerous discussions among the agencies and on January 9, 2023, EPA and ACOE signed a joint collaboration memorandum to work towards identifying an approach to reduce flood risk in the Yazoo Backwater Area.[5]

Discussion

Following the collaborative process, on June 28, 2024, ACOE issued a Draft EIS identifying a "new" pumping project with a 45-day public comment period initially ending on August 12, 2024, but extended to August 27, 2024. Although this plan does include some "mandatory buy-outs"of 52 homes in economically-disadvantaged communities in the Yazoo Backwater Area, it also includes a substantial pump that has the potential to drain the same or similar wetlands identified in the 2008 Section 404(c) Determination and potentially more. EPN believes that, similar to our earlier position on the 2020 version of the project, this proposed project would not be allowed under the 2008 Final Determination unless that Determination is modified following practices EPA had established in prior actions.

It is important to note that the 2008 Final Determination anticipated and prohibited any similar pump projects located within the Yazoo Backwater Area identified in the Final Determination that would have the same or similar adverse impacts within the project area. Simply moving the location of the pumps upstream within the same defined project area, changing the fuel used by the pumps, changing the size of the pumps, or changing pump operation parameters does not significantly alter the project impacts or its purpose. In the 2008 Final Determination, EPA noted that "derivatives of the prohibited projects that involve only small modifications to the operational features or location of these proposals would also likely result in unacceptable adverse effects and would generate a similar level of concern and review by EPA."[6] This language indicated that "derivatives" and "changes in location" were presumptively covered by the Final Determination, because of the likelihood they would have similar impacts, but that EPA would review such impacts if such changes were proposed.

Precedents for Modifying a 404(c) Final Determination

In order to modify the project, we believe ACOE should seek modification of the 2008 Final Determination issued by EPA. In an August 22, 2019 letter from the Regional Administrator to ACOE, EPA informed ACOE in writing about the detailed information ACOE would need to submit to EPA along with a formal request before the agency would review the 2008 Final Determination.[7]

Section 404(c) and the implementing regulations in 40 CFR Part 231 specifically note that a Final Determination issued by the EPA Administrator under Section 404(c) is a final agency action that is then

[5] Joint Memorandum of Collaboration Between the U.S. Department of the Army (Civil Works) and U.S. Environmental Protection Agency, January 9, 2023.

[6] Final Determination of the U.S. Environmental Protection Agency's Assistant Administrator for Water Pursuant to Section 404(c) of the Clean Water Act Concerning the Proposed Yazoo Backwater Area Pumps Project Issaquena County, Mississippi. August 31, 2008. page iv.

[7] August 22, 2019 letter from Mary S. Walker, Regional Administrator, EPA Region 4, to Major General R. Mark Toy.

subject to review in the courts. Absent court review, the path for ACOE to take to modify the project is to use the applicable Section 404(c) procedures.

During the history of the Section 404(c) program, EPA has issued 14 Final Determinations. EPA has directly modified only two of the issued Final Determinations to address changed circumstances or different needs. In both cases, EPA went through the appropriate public process identified in the implementing regulations, after a specific detailed request from ACOE to modify the Section 404(c) Final Determination. This included the issuance of a public notice, the review and response to public comments, and the issuance of an amendment to the Final Determination. In both prior cases, the project changes and impacts were minor. However, although the 2020-21 Yazoo Pump project changes from the 2008 project were relatively minor, the overall project impacts are still major. The same applies to the 2024 proposed plan.

By not following this process we believe EPA and ACOE did not fully consider the complex set of concerns voiced by stakeholders directly and indirectly affected by the project, including serious environmental justice concerns.

<u>Conclusion</u>

EPN believes that the 2008 Final Determination clearly prohibits discharges for the purpose of construction and operation of the proposed pump "or any similar pump project" within the defined project area that would result in similar or adverse impacts to jurisdictional wetlands and other waters of the United States. Similar to concerns EPA identified in the 2008 Final Determination and EPN expressed on earlier versions of the pumping project, EPN's concerns with the potential adverse impacts of this version of the project remain.

However, if ACOE remains committed to moving forward with this version of the project, the ACOE should follow the long-standing approach to modify a CWA Section 404(c) final agency action by making a formal request to EPA. As noted above, EPA previously outlined the necessary information that should be submitted.[8]

This letter was prepared by EPA alumni and EPN volunteers Philip Mancusi-Ungaro and James Giattina. If you have any questions or if we can provide any further information, please contact us.

Sincerely,

Michelle Roos

Michelle Roos
Executive Director
Environmental Protection Network

[8] August 22, 2019 letter from Mary S. Walker, Regional Administrator, EPA Region 4, to Major General R. Mark Toy.

cc: Michael Connor
Assistant Secretary of the Army for Civil Works

Lieutenant General Scott A. Spellmon
Chief of Engineers, ACOE

Bruno Pigott
Acting Assistant Administrator for Water, EPA

Brian Frazer
Director, Office of Wetlands, Oceans and Watersheds, EPA

Jeaneanne Gettle
Acting Regional Administrator, EPA Region 4

Jeffrey Prieto
Acting General Counsel, EPA

YazooBackwater@usace.army.mil

Attachment C

Comments on the Draft Environmental Impact Statement for the Yazoo Backwater Area Water Management Project, June 2024

Submitted by

National Wildlife Federation, National Audubon Society, Sierra Club Audubon Delta, Healthy Gulf, Sierra Club Mississippi

August 27, 2024

August 26, 2024

The Honorable Michael Connor
Assistant Secretary of the Army (Civil Works)
U.S. Army Corps of Engineers
108 Army Pentagon (3E446)
Washington, DC 20310-0108
michael.l.connor10.civ@army.mil

Colonel Jeremiah A. Gipson
Vicksburg District Commander
U.S. Army Corps of Engineers
4155 Clay Street
Vicksburg, MS 39183-3435
YazooBackwater@usace.army.mil

Re: Community Letter on Yazoo Backwater Area Draft Study Process

Dear Assistant Secretary Connor and Colonel Gipson,

The 56 undersigned community members, homeowners, and landowners from Sharkey and Issaquena Counties write to express our continued opposition and outrage to the U.S. Army Corps of Engineers' (Corps) latest plan for the Yazoo Backwater Area. We will not let you ignore our voices.

As we have told the Corps over and over again: We want effective flood relief through nonstructural and nature-based solutions that honors and respects our underserved communities—not the false promise of the Yazoo Pumps.

On top of pushing another sham version of the Yazoo Pumps onto our communities, you now propose to take our homes and property through eminent domain and condemnation under the shameful perversion of environmental justice. This is not flood relief, this is a violation of the generational struggles our Black communities have endured in rising up against abuse, poverty, and injustice. The legacy of our communities and our families will not be sacrificed to feed the desire of affluent farm owners.

Time after time, we have urged you to abandon any version of the Yazoo Pumps because we know the real truth—the Pumps will not keep our communities from flooding. The Pumps are all about enriching large farm owners by helping them plant more crops on low-lying lands while our genuine needs and requests continue to be dismissed. It is an affront to the legitimate health, safety, and recovery needs of our communities that your plan to operate the Pumps is entirely driven to benefit wealthy agricultural interests. This plan is even more appalling in the face of our continued struggle to recover from the devastating 2023 tornado and the daily hardships of persistent racial and environmental injustice.

Once again, we call on you to abandon this and any version of the Yazoo Pumps and to instead work with the Environmental Protection Agency, U.S. Department of Agriculture, and others to quickly implement nature-based and nonstructural solutions that can help us recover and thrive. These solutions include elevating and flood-proofing homes, businesses and roads protecting targeted areas with floodplain easements; and engaging with Yazoo backwater farm owners to expand conservation easements and related wetland restoration, which would provide additional flood protection for our communities. Targeted, voluntary relocations and buy-outs should also be pursued if willing community members can be given enough money to allow them to relocate to areas that will be flood free.

We call on you to begin to address the substantial needs of our low-income, minority communities by investing the hundreds of millions of our tax dollars needed to build the phony Pumps into these vital programs. Our communities deserve respect, action, and compassion, not yet another false promise of being saved by the Yazoo Pumps while our homes and businesses are stripped from us.

Please reach out to Ty Pinkins at ty@typinkins.com if you have any questions.

Sincerely,

Ty Pinkins
Founder & President
The Pyramid Project, Sharkey County

Roy Rucker
CEO
Tardigrade Communications, Sharkey County

Jessica Berdley
Homeowner, Sharkey County

Herbert Brown
Homeowner, Sharkey County

Leon Brown
Homeowner, Sharkey County

Tonyika Bryant
Homeowner, Sharkey County

Sallie Burden
Homeowner, Sharkey County

Shawonder Harris
Homeowner, Sharkey County

Denisha Jackson
Homeowner, Sharkey County

Freddie Jackson
Homeowner, Sharkey County

Robert Jackson
Homeowner, Sharkey County

Rodney Jackson
Homeowner, Sharkey County

Rosie Jackson
Homeowner, Sharkey County

Willie Jackson
Homeowner, Sharkey County

Cornell Knight
Homeowner, Sharkey County

Sylvester Pinkins
Homeowner, Sharkey County

Felicia Brown
Landowner, Sharkey County

Darlene Brown
Landowner, Sharkey County

Luella Brown
Landowner, Sharkey County

Troy Brown
Landowner, Sharkey County

Vanaleen Dennis
Landowner, Sharkey County

Larry Diggs
Landowner, Issaquena County

Michael Franklin
Landowner, Sharkey County

Michaela Franklin
Landowner, Sharkey County

Claretta Hite
Landowner, Sharkey County

James Hite
Landowner, Sharkey County

Suprina Hite
Landowner, Sharkey County

Alfred Jackson
Landowner, Sharkey County

Don Jackson
Landowner, Issaquena County

Juanita Jackson
Landowner, Sharkey County

Monica Jackson
Landowner, Sharkey County

Quintavius Jackson
Landowner, Sharkey County

Hattie Lewis
Landowner, Issaquena County

Robert Lewis
Landowner, Issaquena County

Patricia Mason
Landowner, Issaquena County

Patricia Pinkins
Landowner, Sharkey County

Regina Pinkins
Landowner, Sharkey County

DeBorah Williams
Landowner, Issaquena County

Tonya Battee
Community Member, Sharkey County

Sentha Bullock
Community Member, Sharkey County

Henry Burden
Community Member, Sharkey County

Sonya Burden
Community Member, Sharkey County

Tonya Burden
Community Member, Sharkey County

Samantha Gordon-Pinkins
Community Member, Sharkey County

Roshunda Harris
Community Member, Sharkey County

Danika Hite
Community Member, Sharkey County

Jermaine Hite
Community Member, Sharkey County

Quanta Hite
Community Member, Sharkey County

Tiffany Hite
Community Member, Sharkey County

Antwan Jackson
Community Member, Sharkey County

Christian Jackson
Community Member, Sharkey County

Nathaniel Jackson
Community Member, Sharkey County

Rodney Ousley
Community Member, Sharkey County

Travis Pinkins
Community Member, Sharkey County

Willie Pinkins
Community Member, Sharkey County

Peggy Thomas
Community Member, Issaquena County

THE PYRAMID PROJECT

August 26, 2024

The Honorable Michael Regan
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, N.W.
Washington, DC 20460

The Honorable Michael Connor
Assistant Secretary of the Army (Civil Works)
108 Army Pentagon (3E446)
Washington, DC 20310-0108

Re: My Community Deserves 21st-Century Flood Solutions Not the Phony Yazoo Pumps

Dear Administrator Regan and Assistant Secretary Connor,

As a proud son of the Mississippi Delta, I fight every day to ensure communities across the region get the justice, equality, and resources they need and deserve—whether it's the daily struggle to make ends meet, in breaking through systemic racial injustice, or recovering from the 2023 tornado tragedy that wiped my hometown of Rolling Fork off the map.

So it is with great urgency that I write to you once again to call out your agencies' unacceptable and offensive pursuit of the Yazoo Backwater Pumps, a project that is a slap in the face to Black community members of the Yazoo Backwater Area. Your agencies' deliberate decision casts aside the honest requests many other minority community members and I have made in asking you to disavow the Yazoo Pumps and put your energies into providing effective 21st-century flood relief programs and environmental justice resources, especially through nonstructural and nature-based approaches.

Community members like me are not fooled by the false claims that the Yazoo Pumps are the only solution to protect us from flooding. In fact, your latest plan to operate the Pumps around planting seasons lays bare what we have known all along—that this project is little more than a corporate giveaway that helps large farm owners plant more crops on low-lying farms. Building the Pumps will spend more than a billion of our tax dollars so rich farm owners can get even richer while our communities remain vulnerable to flooding in the face of structural inequity and tornado recovery.

To add further insult, your Pumps plan now shockingly proposes forced removal of Black community members' homes and property through "mandatory" acquisition under the guise of "environmental justice"—an obscene perversion that could not be further from the truth. Not only does this reprehensible proposal further reinforce that the Pumps are designed to benefit wealthy white farmers, it perpetuates the oppressive burdens my fellow Black community members, generations of my family, and I have faced and work so hard to overcome. This is eminent domain pure and simple.

All of this on top of the fact that your proposal roundly ignores the repeated requests from many low-income and minority residents from the Yazoo Backwater Area for swift help in delivering 21st-century flood mitigation programs and funding, especially through effective nonstructural and nature-based flood relief tools. My work with disadvantaged communities in the Yazoo backwater to secure non-financial technical assistance through the FEMA BRIC program demonstrates their desire for these effective flood relief solutions—solutions that are available and funded and could quickly be put to work to benefit people's lives and property while helping to address many fundamental hardships.

I call on you to take the Yazoo Pumps and their false promise of flood relief off the table once and for all, and to immediately work to put nonstructural and nature-based flood solutions in place that can help vulnerable Yazoo backwater communities.

Sincerely,

Ty Pinkins
Founder & President
The Pyramid Project, Sharkey County

August 4, 2023

The Honorable Michael Connor
Assistant Secretary of the Army (Civil Works)
U.S. Army Corps of Engineers
108 Army Pentagon (3E446)
Washington, DC 20310-0108
michael.l.connor10.civ@army.mil

Colonel Christopher Klein
Commander
U.S. Army Corps of Engineers-Vicksburg District
4155 Clay Street
Vicksburg, MS 39183-3435
YazooBackwater@usace.army.mil

Re: Community Letter on Yazoo Backwater Area Scoping Process

Dear Assistant Secretary Connor and Colonel Klein,

The 50 undersigned community members, homeowners, and landowners from Sharkey and Issaquena Counties submit this letter in response to the U.S. Army Corps of Engineers' (Corps) July 6, 2023, announcement to prepare a plan for the Yazoo Backwater Area.

We represent rural, underserved communities in the Yazoo backwater where many are forced to struggle every day to make ends meet in the face of pervasive racial and environmental injustices. These hardships have been made much worse by the devastating tornado that recently tore through the heart of our community. We are still in shock and are still mourning the loss of family members, friends, and neighbors.

In the face of our distress and grief, we cannot understand why your agency continues to devote so much time and energy to coming up with yet another version of the Yazoo Pumps instead of helping us recover. We remind you that dozens of Black community leaders and members have urgently asked for nature-based and non-structural flood relief solutions—not a pump.

For decades, the Yazoo Pumps have been held out as the promised solution to flooding in our counties and the rest of Mississippi's Yazoo Backwater Area, but we are not fooled. The Yazoo Pumps will not keep us safe from flooding—the Pumps will simply help enrich large farm owners so they can plant more crops on low-lying lands while our needs and requests continue to be ignored.

The hundreds of millions, and likely billions, of our tax dollars needed to build the pumps would be far better spent on providing meaningful flood relief and economic opportunities to help redress the environmental and other injustices that plague our communities of color. Also, it is outrageous that these same pumps would dump billions of gallons of water downstream, making flooding problems even worse for our mostly Black neighbors in North Vicksburg. Our overlooked communities need effective flood relief now—not the false promise of the Pumps.

Once again, we urge you to abandon this and any version of the Yazoo Pumps and to instead work with the Environmental Protection Agency, U.S. Department of Agriculture, and others to quickly implement nature-based and non-structural solutions that can help us recover and thrive. These solutions include elevating and flood-proofing homes, businesses and roads; carrying out voluntary relocations and buy-outs; protecting targeted areas with floodplain easements; and engaging with Yazoo backwater farm owners to expand conservation easements and related wetland restoration, which would provide additional flood protection for our communities.

These investments would serve as a meaningful down payment to begin to address the substantial needs of our low-income, minority communities—needs that have grown exponentially in the face of the catastrophic tornados that have devastated our area. Our communities deserve compassion and help in their time of need, not yet another false promise of being saved by the Yazoo Pumps.

Please reach out to Ty Pinkins at ty@typinkins.com if you have any questions.

Sincerely,

Ty Pinkins
Founder & President
The Pyramid Project, Sharkey County

Jessica Berdley
Homeowner, Sharkey County

Herbert Brown
Homeowner, Sharkey County

Leon Brown
Homeowner, Sharkey County

Tonyika Bryant
Homeowner, Sharkey County

Sallie Burden
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Matthew Caldwell
Landowner, Issaquena County

Sharon Caldwell
Landowner, Issaquena County

Steven Caldwell
Landowner, Issaquena County

Oliver Clark
Landowner, Issaquena County

Vanaleen Dennis
Landowner, Sharkey County

Larry Diggs
Landowner, Issaquena County

Claretta Hite
Landowner, Sharkey County

James Hite
Landowner, Sharkey County

Alfred Jackson
Landowner, Sharkey County

Don Jackson
Landowner, Issaquena County

Juanita Jackson
Landowner, Sharkey County

Monica Jackson
Landowner, Sharkey County

Hattie Lewis
Landowner, Issaquena County

Robert Lewis
Landowner, Issaquena County

Patricia Pinkins
Landowner, Sharkey County

Regina Pinkins
Landowner, Sharkey County

Henry Sias
Landowner, Issaquena County

Alice Washington
Landowner, Issaquena County

Quincy Washington
Landowner, Issaquena County

Tonya Battee
Community Member, Sharkey County

Sentha Bullock
Community Member, Sharkey County

Samantha Gordon-Pinkins
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Nathaniel Jackson
Community Member, Sharkey County

Rodney Ousley
Community Member, Sharkey County

Travis Pinkins
Community Member, Sharkey County

Willie Pinkins
Community Member, Sharkey County

Peggy Thomas
Community Member, Issaquena County

June 2, 2023

The Honorable Michael Regan
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, N.W.
Washington, DC 20460

The Honorable Michael Connor
Assistant Secretary of the Army (Civil Works)
108 Army Pentagon (3E446)
Washington, DC 20310-0108

Re: The Yazoo Pumps are a Blatant Environmental Injustice

Dear Administrator Regan and Assistant Secretary Connor,

My experiences growing up in Rolling Fork Mississippi, shaped me to become the veteran, attorney, and community organizer I am today. These experiences continue to guide and motivate my work with underserved communities throughout the Mississippi Delta, including in the Yazoo Backwater Area where many are forced to struggle every day to make ends meet and break through the endemic racial injustices that plague this region—adversities made even worse by the recent tornado disaster.

In the face of these injustices, your agencies' recent decision to push yet another variation of the Yazoo Pumps is a slap in the face to the communities of color in the Yazoo Backwater. It really is quite shocking that the Biden Administration would propose this project, since its true purpose is to help already rich farm owners get even richer by planting more crops on their large low-lying farms while the needs and requests of Black community members continue to be ignored. Inexcusably, these same pumps will dump billions of gallons of floodwater downstream, making flooding problems even worse for our mostly Black neighbors.

Simply put, the Yazoo Pumps are a blatant environmental injustice. The hundreds of millions, and likely more than a billion, of our tax dollars needed to build the pumps would be far better spent on providing meaningful flood relief and economic opportunities to help redress the environmental and other injustices that plague the Yazoo Backwater Area's Black community members.

Your announcement is even more disturbing in light of the repeated requests to your agencies from many low-income and minority residents from the Yazoo Backwater for urgent help in accessing effective flood mitigation and environmental justice-focused programs and funding, especially through nonstructural and nature-based flood mitigation tools. I have also been working with area communities to access these tools through federal grant opportunities—most recently securing a FEMA BRIC FY22 award for non-financial technical assistance for the Yazoo Backwater communities of Rolling Fork and Mayersville. But it is clear that deployment of these effective flood relief solutions will not happen at scale unless the Yazoo Pumps and their false promise of flood relief are taken off the table once and for all.

I call on you to abandon the Yazoo Pumps and instead to immediately work on putting non-structural, natural and nature-based flood solutions in place that can help our vulnerable communities.

Finally, it is incredibly disturbing that your agencies continue to jump through hoops to meet the arbitrary timelines included in your January agreement, while Rolling Fork and Sharkey County remain in shambles from one of the most devastating tornados ever to hit Mississippi.

Residents of Rolling Fork and Sharkey County are still in shock and are still mourning the loss of family members, friends, and neighbors. We do not understand why your agencies have devoted so much time and energy to coming up with yet another version of the Yazoo Pumps instead of helping them recover.

Sincerely,

Ty Pinkins
Founder & President
The Pyramid Project, Sharkey County

EEECHO
Education, Economics, Environmental, Climate and Health Organization
P. O. Box 7803 Gulfport, MS 39507
228-617-0891 eeechomovement@gmail.com

May 30, 2023

The Honorable Michael Regan
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, N.W.
Washington, DC 20460
via email

The Honorable Michael Connor
Assistant Secretary of the Army (Civil Works)
108 Army Pentagon (3E446)
Washington, DC 20310-0108
via email

RE: Yazoo Pumps are an Environmental Injustice

Dear Administrator Regan and Assistant Secretary Connor:

The Education, Economics, Environmental, Climate and Health Organization (EEECHO) believes that equity is a cornerstone for just solutions that will benefit all communities across the state, including Mississippi's South Delta. The low-income, minority communities of the Yazoo Backwater Area are vulnerable to flooding, a situation that is further complicated by systemic racial and socioeconomic inequalities that plague the region. Your agencies' recent proposal is yet another appalling version of the dangerous Yazoo Pumps that will do nothing but reinforce these pervasive injustices.

We oppose the Yazoo Pumps which would continue the South Delta's long history of prioritizing profits for wealthy farm owners at the expense of Black community members. This project would send more money to Delta farmers while leaving backwater communities unprotected and making flooding problems even worse for predominantly Black neighbors who live downstream. The Yazoo Pumps' false promise of flood protection will not redress the long history of environmental injustices and complex hardships faced by South Delta communities.

We are aware of the fears of the backwater community members and are familiar with their experiences with flooding, and the types of federal resources and support they need to get effective, sustainable flood relief for themselves and for their communities. What is clear is that the only way for the Biden Administration to truly deliver equitable solutions for Yazoo backwater communities—while protecting their downstream neighbors—is to answer their pleas for resources and technical expertise needed to take advantage of federal programs and funding such as through EPA, FEMA, HUD, and DOT. The flood relief help we have heard these community members ask for includes elevating homes, businesses and roads; flood proofing; voluntary relocations and buy-outs; and purchasing floodplain and other conservation easements.

The Biden Administration has made abundantly clear that communities like those of the Yazoo backwater should be prioritized for support and for these equitable, environmentally just flood relief solutions—not another Pumps plan that is so woefully out of line with this vision.

Sincerely,

Ruth Y. Story
Executive Director

C:
The Honorable Bennie G. Thompson
United States Representative
Mississippi's 2nd Congressional District

July 3, 2022

The Honorable Brenda Mallory
Chair
Council on Environmental Quality
730 Jackson Place, N.W.
Washington, D.C. 20503

The Honorable Deanne Criswell
Administrator
Federal Emergency Management Agency
500 C Street, S.W.
Washington, D.C. 20472

Robert Bonnie
Under Secretary for Farm Production and Conservation
U.S. Department of Agriculture
1400 Independence Ave., S.W.
Washington, DC 20250

Carlos Monje
Under Secretary of Transportation for Policy
U.S. Department of Transportation
1200 New Jersey Ave., S.E.
Washington, D.C. 20590

Re: Urgent Request for Assistance in Accessing Funding for Flood Relief

Dear Chair Mallory, Administrator Criswell, Under Secretary Bonnie, and Under Secretary Monje:

We represent rural communities in Sharkey and Issaquena Counties located in the Mississippi Delta that suffer from frequent flooding. Our region has long endured structural, systemic, and racial inequities, and many of our residents struggle every day to make ends meet. As a result, our communities lack the resources and technical expertise needed to take advantage of federal programs that could help us obtain prompt and effective flood relief. Given these hardships, we urgently write to ask for your assistance in accessing these programs and the funding that is available to help vulnerable communities like ours.

For decades, the Yazoo Pumps have been the promised solution to flooding in our counties and the rest of Mississippi's Yazoo Backwater Area. But we know the Yazoo Pumps will not protect us from flooding. At best, the Pumps might help pull water off 17% of flooded lands in the Yazoo Backwater Area during some floods, according to the Corps of Engineers. But in doing so, they would send even more flood waters onto our neighbors downstream. Our communities need effective flood relief now—not a false promise—and there are significant federal monies available that can be quickly put to work to benefit people's lives, property, and livelihoods.

Given the many obstacles our communities face, we respectfully ask you to send staff from the Federal Emergency Management Agency, Department of Agriculture, and Department of Transportation to our communities to help us develop, write, and submit requests for pre- and post-disaster mitigation funding. Since many of these funds are time-sensitive, providing swift support is essential so that our communities can pursue flood mitigation tools such as elevating homes, businesses and roads; flood proofing; voluntary relocations and buy-outs; and floodplain easements. We also urge you to engage with farm owners in the Yazoo Backwater Area to increase the federal purchase of conservation easements and related wetland restoration, which would provide additional flood protection for our communities.

We appreciate the administration's deliberate commitment to ensuring equitable distribution of federal investments to underserved communities of color, and we respectfully ask you to consider our request. Please reach out to Ty Pinkins at ty@typinkins.com if you have any questions or require additional information.

Sincerely,

Ty Pinkins
Founder & President
The Pyramid Project, Sharkey County

Linda Williams-Short
Mayor
Town of Mayersville, Issaquena County

Eldridge Walker
Mayor
Town of Rolling Fork, Sharkey County

Board of Aldermen
Town of Rolling Fork, Sharkey County

Calvin Stewart
Alderman
Town of Rolling Fork, Sharkey County

Roy Rucker
Chief Executive Officer
Tardigrade Communications, Sharkey County

Jessica Berdley
Homeowner, Sharkey County

Herbert Brown
Homeowner, Sharkey County

Leon Brown
Homeowner, Sharkey County

Tonyika Bryant
Homeowner, Sharkey County

Shawonder Harris
Homeowner, Sharkey County

Sylvester Pinkins
Homeowner, Sharkey County

Denisha Jackson
Homeowner, Sharkey County

Freddie Jackson
Homeowner, Sharkey County

Willie Jackson
Homeowner, Sharkey County

Cornell Knight
Homeowner, Sharkey County

Mike Ainsworth
Landowner, Issaquena County

Stephanie Booker
Landowner, Issaquena County

Felicia Brown
Landowner, Sharkey County

Troy Brown
Landowner, Sharkey County

Matthew Caldwell
Landowner, Issaquena County

S.L. Caldwell
Landowner, Issaquena County

Sharon Caldwell
Landowner, Issaquena County

Steven Caldwell
Landowner, Issaquena County

Oliver Clark
Landowner, Issaquena County

Vanaleen Dennis
Landowner, Sharkey County

Larry Diggs
Landowner, Issaquena County

Alfred Jackson
Landowner, Sharkey County

Don Jackson
Landowner, Issaquena County

Juanita Jackson
Landowner, Sharkey County

Monica Jackson
Landowner, Sharkey County

Hattie Lewis
Landowner, Issaquena County

Robert Lewis
Landowner, Issaquena County

Allen Mason
Landowner, Issaquena County

Patricia Mason
Landowner, Issaquena County

Patricia Pinkins
Landowner, Sharkey County

Regina Pinkins
Landowner, Sharkey County

Henry Sias
Landowner, Issaquena County

Letha Taylor
Landowner, Issaquena County

Alice Washington
Landowner, Issaquena County

Quincy Washington
Landowner, Issaquena County

DeBorah Williams
Landowner, Issaquena County

Tonya Battee
Community Member, Sharkey County

Samantha Gordon-Pinkins
Community Member, Sharkey County

Jermain Hite
Community Member, Sharkey County

Nathaniel Jackson
Community Member, Sharkey County

DeEdgar Pinkins
Community Member, Sharkey County

Travis Pinkins
Community Member, Sharkey County

CC: The Honorable Bennie G. Thompson, Mississippi's 2nd Congressional District, and Chairman, House Committee on Homeland Security
The Honorable Michael Regan, Administrator, U.S. Environmental Protection Agency
The Honorable Michael Connor, Assistant Secretary of the Army for Civil Works
The Honorable Martha Williams, Director, U.S. Fish & Wildlife Service
The Honorable Radhika Fox, Assistant Administrator for Water, U.S. Environmental Protection Agency

Attachment D

Comments on the Draft Environmental Impact Statement for the Yazoo Backwater Area Water Management Project, June 2024

Submitted by

National Wildlife Federation, National Audubon Society, Sierra Club
Audubon Delta, Healthy Gulf, Sierra Club Mississippi

August 27, 2024

August 27, 2024

The Honorable Michael S. Regan
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, N. W.
Washington, D.C. 20460

Re: Protect Hemispherically Vital Wetlands in the Yazoo Backwater Area of Mississippi

Dear Administrator Regan:

On behalf of our millions of members and supporters, the 139 undersigned conservation, social justice, local government, professional, faith-based, and recreation organizations and businesses urgently ask you to protect the hemispherically significant wetlands in the Yazoo Backwater Area of Mississippi by enforcing your agency's long-standing Clean Water Act 404(c) veto protecting this area. These exceptional wetlands are once again at risk from the U.S. Army Corps of Engineers' (Corps) proposed Yazoo Backwater Pumping plant—an agricultural drainage project being promoted as flood control.

Many of us joined with more than 130 conservation and social justice organizations and dozens of community members to call on the Corps to abandon the Yazoo Pumps during the scoping phase for this latest proposal. We urged the Corps to instead deploy effective, environmentally sustainable non-structural, natural, and nature-based flood risk reduction measures that would benefit communities and wildlife.[1,2] But the Corps continues to pursue its plan[3] to build the largest pumping plant in the world to benefit industrial-scale agriculture on marginal lands that have always flooded. The water drained by these massive 25,000 cubic-feet-per-second pumps, up to 16 billion gallons a day, will be pushed into an already flooded Yazoo River, increasing flood risks for highly vulnerable downstream communities that suffer from pervasive and systemic environmental injustices.[4]

This version of the Yazoo Pumps would damage 89,800 to more than 93,300 acres[5] of vital wetlands—an area of wetlands **twice as large as Washington, D.C., and ten times larger than the area of wetlands protected by all other 404(c) vetoed projects combined.** Your agency has already determined that this

[1] Scoping comments on the Yazoo Backwater Area Pumping Plant (88 Fed. Reg. 43101) submitted by 133 conservation and social justice organizations on August 7, 2023 (available at https://waterprotectionnetwork.org/wp-content/uploads/2023/08/Group-Letter_Yazoo-Pumps-NOI_Final.pdf).

[2] Letter from 50 community members on the Yazoo Backwater Area Scoping Process submitted on August 4, 2023 (available at https://waterprotectionnetwork.org/wp-content/uploads/2023/08/Community-Letter_Corps-Yazoo-Scoping_8-4-23.pdf).

[3] The Corps identified the same plan as its preliminarily preferred plan in the Notice of Intent to Prepare an Environmental Impact Statement for the Yazoo Backwater Area Water Management Project, 88 Fed. Reg. 43101 (July 6, 2023).

[4] The Corps' plan also includes "mandatory buy-outs"—i.e., eminent domain and condemnation—of 52 homes in economically disadvantaged communities in the Yazoo Backwater Area.

[5] The Corps has identified two identical preliminary preferred alternatives (Alternatives 2 and 3) except for operating plans that differ by just 9 days. The Corps has proposed compensatory mitigation of just 5,722 to 7,650 acres, depending on the operating plan selected. U.S. Army Corps of Engineers, Draft Environmental Impact Statement for the Yazoo Backwater Area Water Management Project (July 2024) at 38, Wetland Appendix at 34.

plan would cause unacceptable impacts to "some of the richest wetland and aquatic resources in the nation" including vital bottomland hardwood wetlands that have long been recognized as being "among the Nation's most important wetlands."[6] These impacts are all the more unacceptable in light of the nation's alarming increase in wetland losses[7] and the Supreme Court's 2023 decision in *Sackett v. Army Corps of Engineers* that has left millions of acres of wetlands without Clean Water Act protection.

Fortunately, the Corps' latest plan is explicitly barred by your agency's long-standing veto, which prohibits "alterations to the spatial extent, depth, frequency, and duration of inundation of wetlands" that "would significantly degrade the critical ecological functions provided by approximately 28,400 to 67,000 acres of wetlands . . . in the Yazoo Backwater Area, including those functions that support wildlife and fisheries resources."[8] The veto further confirms that more extensive ecological impacts would also be unacceptable.[9]

Under your leadership, EPA wisely reasserted this scientifically based veto in November 2021 to protect the region's wetlands from the Corps' attempt to resurrect the Yazoo Pumps under the previous administration.[10] This important decision to enforce the veto opened the door for deploying demonstrably effective natural, nature-based and non-structural solutions for the Yazoo backwater Area that would reduce flood risks for vulnerable communities while protecting and restoring the region's hemispherically significant wetlands and making it more resilient to climate change. Your agency along with local community leaders, the conservation community, hundreds of scientists, the U.S. Fish and Wildlife Service, and others have repeatedly asked the Corps to deploy these types of commonsense solutions for the Yazoo Backwater Area.

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[6] Final Determination of the U.S. Environmental Protection Agency's Assistant Administrator For Water Pursuant To Section 404(C) Of The Clean Water Act Concerning The Proposed Yazoo Backwater Area Pumps Project, Issaquena County, Mississippi, August 31, 2008 (Clean Water Act 404(c) Final Determination). The veto also makes it clear that the adverse effects of the Yazoo Pumps "are the result of a combination of operational factors including the capacity of the pumping station and its associated pump-on elevations."
[7] Lang, M.W., Ingebritsen, J.C., Griffin, R.K. 2024. Status and Trends of Wetlands in the Conterminous United States 2009 to 2019. U.S. Department of the Interior; Fish and Wildlife Service, Washington, D.C. 43 pp.
[8] Id. at iii, 72.
[9] Id. at iii ("Although not proposed to go forward, FSEIS Plans 3, 4, and 7 . . . are expected to result in wetland impacts between approximately 28,400 and 118,400 acres" and "EPA has determined that each of these alternatives would also result in unacceptable adverse effects on fishery areas and wildlife.")
[10] This decision put a stop to the previous administration's Yazoo Pumps plan that was opposed by more than 110 scientific professionals, the Society of Wetland Scientists, the Society of Freshwater Science, the North American Lake Management Society, and more than 120 national, state and local conservation, faith-based, social justice, and recreation organizations among many others.

Instead of working to deploy these solutions through a whole of government approach, the Corps has once again recommended a massive pumping plant that will damage wetlands at a scale that this nation cannot afford. Our organizations call on you to prevent this from happening by enforcing the 2008 Clean Water Act 404(c) veto of the Yazoo Pumps.

Sincerely,

Stephanie Robinson
Co–Executive Director & Development Director
350 Wisconsin

Debra Campbell
Secretary and Treasurer
A Community Voice

Leo Carney
State Director
ADOS Empowerment Project

Kevin Shockey
Founder and Executive Director
Ahora Inc.

Pamela Miller
Founder and Executive Director
Alaska Community Action on Toxics

Eliza Evans
Climate Change Activist and Artist
All the Way to Hell

Eileen Shader
Sr. Director, Floodplain Restoration
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Roxanne Blackwell
Managing Director of Government Affairs
American Society of Landscape Architects

Thomas Anderson
Administrative Director
Amigos de Bolsa Chica

Elizabeth Hartfield
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Jackson Audubon Society

Sarah Gray
Owner
Jarden Native Plants designs

Pastor Dr. Charlotte L. Keys
CEO
Jesus People Against Pollution

Michael Washburn
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Rylee Hince
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Mayci Shimon
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Asociacion de Residentes de La Margarita, Inc.

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Charles Scribner
Executive Director
Black Warrior Riverkeeper

Anne Millbrooke
Designated Signer
Bozeman Birders

Myra Crawford
Executive Director
Cahaba Riverkeeper

Chris Shutes
Executive Director
California Sportfishing Protection Alliance

Brett Hartl
Govt Affairs Director
Center for Biological Diversity

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Founder and Co-Chair
Clean Air For All Now

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National Water Campaigns Coordinator
Clean Water Action

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Water & Agriculture Program Director
Clean Wisconsin

Gabriella Velardi-Ward
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Coalition for Wetlands and Forests

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Committee on the Middle Fork Vermilion River

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Jeff Moore
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Lydia Marie Kelley
Authorized Signer
Ebony Misses

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Parable of the Sower Intentional Community Cooperative

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Project Eleven Hundred

Eloy Ortiz
Special Projects Manager
Regeneración - Pajaro Valley Climate Action

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executive director
San Antonio Bay Estuarine Waterkeeper

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Policy Staff
Friends of the River

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Executive Director
GASP

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President
Good Stewards of Rockingham

Fred Akers
Operations Manager
Great Egg Harbor Watershed Association

Krystal N. Martin
Founder
Greater Greener Gloster

Krystal N. Martin
CEO & Founder
Greater Greener Gloster Project

Sandra Lovely
Founder
Greater Neighborhood Alliance of Jersey City, NJ

Erin Meier
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Green Lands Blue Waters

Val Schull

Jacqueline Echols
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South River Watershed Alliance

Virginia Richard
Gulf Program Director
SouthWings

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Executive Director
Spirit of the Sun Inc

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Executive Director
Steps Coalition

Laurie Ward
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Stop the Lies. Stop the landfill

Michael Brown
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Sustaining Way

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Tyrone Pinkins
President
The Pyramid Project

Paul Botts

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Theaux M. Le Gardeur
Executive Director
Gunpowder RIVERKEEPER

Dr. Angela M Chalk
Executive Director
Healthy Community Services

Andrew Whitehurst
Water Program Director
Healthy Gulf

Susie McGovern
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Hoosier Environmental Council

Dr. Maureen Hackett
President & Founder
Howling For Wolves

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HUBitual Learning and Outreach

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Iowa Natural Heritage Foundation

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Izaak Walton League of America

Executive Director & President
The Wetlands Initiative

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Deputy Director
Waterkeepers Chesapeake

Wynnie-Fred Victor Hinds
Executive Director
Weequahic Park Association

Na'Taki Osborne Jelks
Co-Founder and Executive Director
West Atlanta Watershed Alliance

Debra Buffkin
Executive Director
Winyah Rivers Alliance

cc: Brenda Mallory, Chairperson, CEQ
Martha Williams, Director, USFWS
Bruno Pigott, Acting Assistant Administrator for Water, EPA
Brian Frazer, Director, Office of Wetlands, Oceans and Watersheds, EPA
Michael Connor, Assistant Secretary of the Army for Civil Works
Lieutenant General Scott A. Spellmon, Chief of Engineers, USACE
YazooBackwater@usace.army.mil

August 7, 2023

Submitted by e-mail to: YazooBackwater@usace.army.mil and michael.l.connor10.civ@army.mil

The Honorable Michael Conner
Assistant Secretary of the Army (Civil Works)
U.S. Army Corps of Engineers
Department of Defense
108 Army Pentagon
Washington, DC 20310-0108

Colonel Christopher Klein
Commander
U.S. Army Corps of Engineers
Vicksburg District
4155 Clay Street
Vicksburg, MS 39183-3435

Re: Yazoo Backwater Area Pumping Plant—88 Fed. Reg. 43101 (July 6, 2023)

Dear Assistant Secretary Connor and Colonel Klein:

On behalf of our millions of members and supporters, the 133 undersigned conservation, faith-based, social justice, and recreation organizations urge the U.S. Army Corps of Engineers (Corps) to permanently abandon efforts to build any variation of the environmentally destructive, dangerous Yazoo Backwater Pumping Plant. Instead of continuing to push for this agricultural drainage project, the Corps should support deployment of highly effective non-structural, natural, and nature-based flood risk reduction solutions as also requested by many local community leaders.

The 25,000 cubic-feet-per-second (cfs) pumping plant in the Corps' Preferred Alternative violates federal law and policy and conflicts with this Administration's important conservation and justice priorities. These massive hydraulic pumps would be the largest in the world, with a pumping capacity **78% larger** than the 14,000 cfs pumps prohibited by the longstanding Clean Water Act 404(c) veto of the Yazoo Pumps.[1] They will be operated on a schedule driven by the needs and desires of large agricultural producers who are farming marginal lands that have always flooded and that will continue to flood even with the pumps in place.[2]

These massive pumps could drain enough water from the Yazoo Backwater Area each day to fill more than 17 New Orleans' Superdomes, draining and damaging hemispherically significant wetlands. At full capacity, these pumps would push **16 billion gallons of water a day** into an already flooded Yazoo River, increasing flood risks for highly vulnerable downstream communities that suffer from pervasive and systemic environmental injustices.

The Corps' selection of a Preferred Alternative at this stage of its new study process—and the limits it has imposed on its analysis of alternatives—turns the law on its head. For example, the Corps

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[1] Pumps of this size would cost the federal taxpayers well over $1.4 billion. The West Closure Complex in New Orleans is currently the world's largest pump station, with a pumping capacity of 19,000 cfs powered by 5,000 horsepower diesel engines. The West Closure Complex cost $1.1 billion in 2014. New Orleans Times Picayune, The West Closure Complex: How it works (updated July 18, 2019); NOLA.com, Photos: Largest pump station in the world, located 30 minutes from New Orleans, gets ready for hurricane season (May 12, 2022).
[2] Id.

selected the Preferred Alternative without first conducting the evaluations needed to determine that this alternative will not cause unacceptable damage to hemispherically significant wetlands and the many hundreds of species of fish and wildlife that rely on those wetlands, as prohibited by the 2008 Clean Water Act veto issued by the George W. Bush Administration—which is one of just 14 ever issued. The Biden Administration wisely reasserted this veto in November 2021, putting a stop to the Trump Administration's efforts to end-run the veto during its last days in office.

This Clean Water Act veto protects tens of thousands of acres of wetlands that are "some of the richest wetland and aquatic resources in the nation" and include vital bottomland hardwood wetlands that have long been recognized as being "among the Nation's most important wetlands."[3] Among other things, this veto prohibits "alterations to the spatial extent, depth, frequency, and duration of inundation of wetlands" that "would significantly degrade the critical ecological functions provided by approximately 28,400 to 67,000 acres of wetlands . . . in the Yazoo Backwater Area, including those functions that support wildlife and fisheries resources."[4]

The Corps also selected the USACE Preferred Alternative:

- Without first determining that it is the least environmentally damaging alternative, as required by the Clean Water Act.

- Without first ensuring that the significant adverse impacts to fish, wildlife, and aquatic resources are avoided, minimized, and mitigated, as required by the Water Resources Development Acts and the Clean Water Act.

- Without complying with the Federal Flood Risk Management Standard, which was enacted to ensure that federal agencies make sound flood risk and floodplain management decisions, including ensuring that federal flood mitigation projects will be resilient to floods that are larger than a 100-year flood event.

- Without documenting, through valid hydrologic modeling, that pushing 19 billion gallons of water a day into an already flooded Yazoo River will not increase flood risks for highly vulnerable downstream communities that continue to suffer from pervasive and systemic environmental injustices. The first downstream neighborhood at risk is the Ford Subdivision in North Vicksburg where 93% of residents are Black and 61% of households are low-income. The Ford Subdivision already floods on a regular basis.

The Administration's decision to reassert the Yazoo Pumps Clean Water Act veto in November 2021 opened the door for deploying demonstrably effective natural, nature-based and non-structural

[3] Final Determination Of The U.S. Environmental Protection Agency's Assistant Administrator For Water Pursuant To Section 404(C) Of The Clean Water Act Concerning The Proposed Yazoo Backwater Area Pumps Project, Issaquena County, Mississippi, August 31, 2008 (Clean Water Act 404(c) Final Determination). The veto also makes it clear that the adverse effects of the Yazoo Pumps "are the result of a combination of operational factors including the capacity of the pumping station and its associated pump-on elevations."
[4] Id.

solutions for the Yazoo backwater Area. These solutions would reduce flood risks for vulnerable Yazoo backwater communities while protecting and restoring the region's hemispherically significant wetlands and making communities and the nation's wildlife more resilient to climate change. Local community leaders, the conservation community, hundreds of scientists, the U.S. Fish and Wildlife Service, the U.S. Environmental Protection Agency, and others have repeatedly asked the Corps to deploy these types of solutions for the Yazoo backwater area.

Our organizations urge the Corps to support the prompt deployment of these types of solutions, and abandon pursuit of the environmentally devastating, dangerous, extremely costly, and long-vetoed Yazoo Pumps.

Sincerely,

Debra Campbell
Secretary-Treasurer
A Community Voice

Thomas Anderson
Administrative Director
Amigos de Bolsa Chica

Kevin Shockey
Founder and Executive Director
Ahora Inc.

Harriet Festing
Executive Director
Anthropocene Alliance

Cindy Lowry
Executive Director
Alabama Rivers Alliance

Cameron Baxley
Riverkeeper
Apalachicola Riverkeeper

Pamela Miller
Founder and Executive Director
Alaska Community Action on Toxics

Derek Teaney
Deputy Director
Appalachian Mountain Advocates

Eliza Evans
Climate Change Activist and Artist
All the Way to Hell

Wanda Rios
President
Asociacion de Residentes de La Margarita, Inc.

Olivia Dorothy
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American Rivers

Dean Wilson
Executive Director
Atchafalaya Basinkeeper

Roxanne Blackwell
Director of Federal Government Affairs
American Society of Landscape Architects

Dawn O'Neal
Vice President & Executive Director
Audubon Delta

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Anne Millbrooke
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Bozeman Birders

Myra Crawford
Executive Director
Cahaba Riverkeeper

Chris Shutes
Executive Director
California Sportfishing Protection Alliance

Deirdre Des Jardins
Director
California Water Research

Brett Hartl
Government Affairs Director
Center for Biological Diversity

Trish Rolfe
Executive Director
Center for Environmental Law & Policy

Jonathan Compton
Executive Director
Center for Environmental Transformation

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Chair
Chautauqua-Conewango Consortium

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Committee on the Middle Fork Vermilion River

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Marketing Director
Community In-Power & Development Assoc. Inc.

Treva Gear
Founder and Chair
Concerned Citizens of Cook County

Susan Diane Mitchell
Founder and Co-Executive Director
Dynamite Hill-Smithfield Community Land Trust

Stu Gillespie
Senior Attorney
Earthjustice

Katherine Egland
Founder
Education, Economics, Environmental, Climate and Health Organization (EEECHO)

Daneeta Jackson
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Dan Silver
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Erin Kennedy
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Environmental Defenders of McHenry County

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Friends of the Mississippi River

Fred Akers
Operations Manager
Great Egg Harbor Watershed Association

Krystal N. Martin
Founder
Greater Greener Gloster

Sandra Lovely
Founder
Greater Neighborhood Alliance of Jersey City, NJ

Michael Hansen
Executive Director
Greater-Birmingham Alliance to Stop Pollution

Val Schull
Water Equity and Ocean Program Director
GreenLatinos

Theaux Le Gardeur
Riverkeeper and Executive Director
Gunpowder RIVERKEEPER

Capt. Bill Sheehan
Riverkeeper
Hackensack Riverkeeper

Angela Chalk
Executive Director
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Andrew Whitehurst
Water Program Director
Healthy Gulf

Maureen Hackett
Founder and President
Howling For Wolves

Dimitra McCabe
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Jared Mott
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Charles Pfeifer
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Kentucky Waterways Alliance

Alexander Keilty
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Lake Pepin Legacy Alliance Organization

Mayci Shimon
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LandHealth Institute

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Deputy Legislative Director
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Bike Ride Manager
Louisiana Bucket Brigade

Stacy Ortego
Coastal Policy Manager
Louisiana Wildlife Federation

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June Farmer
Director
Marin City People's Plan

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Executive Director
Mill Creek Alliance

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Leader
Milton’s Concerned Citizens/Save Blackwater River

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Mississippi Chapter of the Sierra Club

Abby Darrah
Chapter President
Mississippi Coast Audubon Society

Lea Campbell
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Attachment E

Comments on the Draft Environmental Impact Statement for the Yazoo Backwater Area Water Management Project, June 2024

Submitted by

National Wildlife Federation, National Audubon Society, Sierra Club
Audubon Delta, Healthy Gulf, Sierra Club Mississippi

August 27, 2024

National Audubon Society eBird Abundance Model Analysis

Audubon has developed an eBird abundance model summary analysis ("abundance analysis") for 180 species of migratory birds found in the region using data from the Cornell Lab of Ornithology and the Partners in Flight Population Estimates Database from Bird Conservancy of the Rockies.[1,2] This abundance analysis was developed to better evaluate and quantify the population-level importance of a geographic location for a bird species during the fall/spring migration, and/or overwintering seasons, so as to strengthen the effectiveness of bird conservation efforts. This model analysis has been peer-reviewed, and a summary of Audubon's methodology is provided in Figure 2, below.[3]

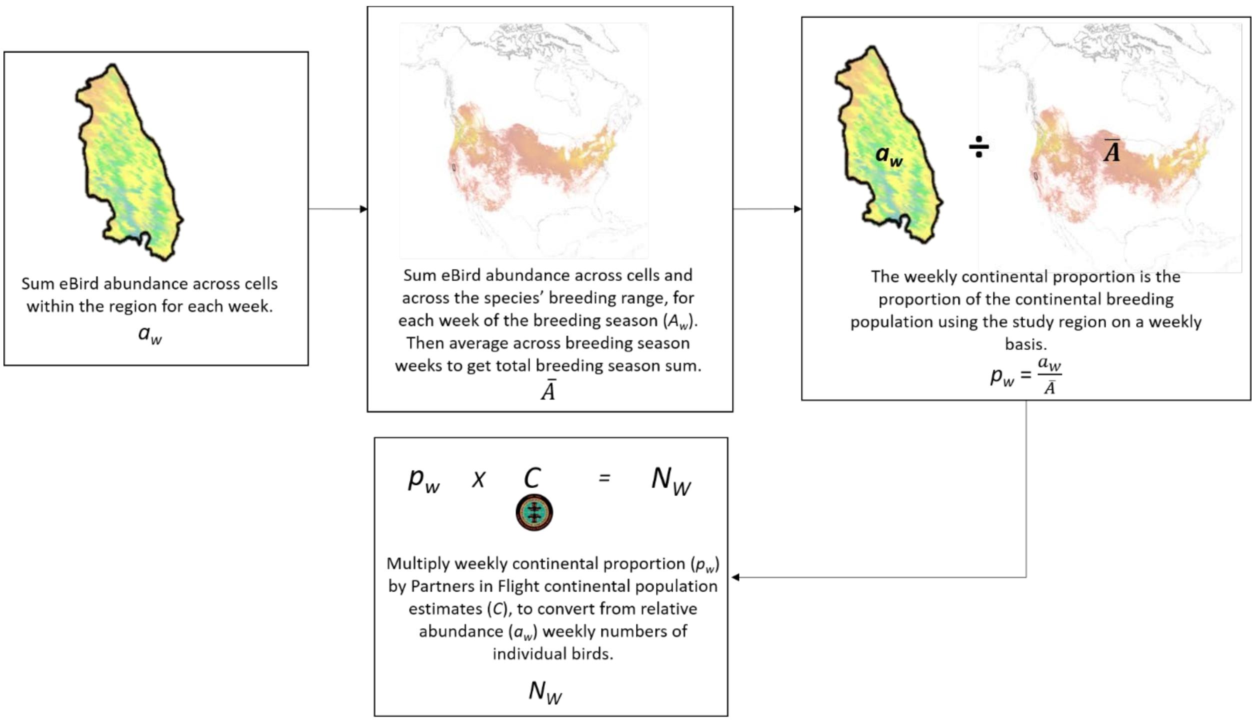

Figure 2, Illustration of the methodology developed by Audubon for its eBird abundance analysis, which was *first completed for the Colorado River Delta and California's Central Valley. This serves as a graphical and mathematical description of the process Audubon used to go from the weekly eBird abundance raster surface in the Sacramento study region to an estimate of total number of individual birds using the region for a given week.*

[1] Fink, D., T. Auer, A. Johnston, M. Strimas-Mackey, O. Robinson, S. Ligocki, B. Petersen, C. Wood, I. Davies, B. Sullivan, M. Iliff, S. Kelling. 2020. eBird Status and Trends, Data Version: 2018; Released: 2020. Cornell Lab of Ornithology, Ithaca, New York *(available at https://doi.org/10.2173/ebirdst.2018)*.

[2] Will, T., J.C. Stanton, K.V. Rosenberg, A.O. Panjabi, A.F. Camfield, A.E. Shaw, W.E. Thogmartin, and P.J. Blancher. 2020. Handbook to the Partners in Flight Population Estimates Database, Version 3.1. PIF Technical Series No 7.1 *(available at pif.birdconservancy.org/popest.handbook.pdf)*.

[3] DeLuca, W, Meehan, T, Seavy, M, Jones, A, Pitt, J, Deppe, J, & Wilsey, C, 'The Colorado River Delta and California's Central Valley are critical for many migrating North American landbirds', *The Condor: Ornithological Applications* (In press).

Audubon’s abundance analysis was used to develop an estimate of annual spring migration (April-May) and fall migration (August-October) landbird and waterbird use of the Yazoo Backwater Area, as well as estimated annual overwintering waterfowl use (December-February). Audubon’s findings substantially reinforce long-standing assessments made by natural resource agencies, scientists, conservation groups, and many others that the Yazoo Backwater Area is a major ecologic lynchpin of the Lower Mississippi River Alluvial Valley because it provides hemispherically significant habitat for many migrating landbirds and waterbirds, and for overwintering waterfowl.

The 2008 veto showcased the rich biodiversity of the region, which includes identifying 257 bird species known to occur in Yazoo Backwater Area.[4] Audubon’s analysis focused on 180 landbird and waterbird species with a reasonable potential to regularly use the Yazoo Backwater Area during spring or fall migration, and that would be reasonably represented by the eBird models, specifically 116 species of landbirds and 64 species of waterbirds.

The analysis found that over 10 million birds (~5.9 million landbirds and ~4.3 million waterbirds) use the Yazoo Backwater Area during spring migration, and more than 18 million birds (~9.1 million landbirds and ~9.6 million waterbirds) use the Yazoo Backwater Area during fall migration. The finding that habitats in the project area annually support an estimated 29 million migrating birds unequivocally demonstrates the population-level importance of the Yazoo Backwater Area for many migrating landbirds and waterbirds.

The line graphs in Figure 3 below show weekly bird migration during spring and fall. The lines represent the estimated number of birds in each guild (i.e., landbirds, waterbirds) using the Yazoo Backwater Area in each week of each season, and the colored ribbon represents a 95% confidence intervals around those estimates. During spring migration, the results demonstrate that waterbirds pass through relatively consistently between March and mid-May, whereas landbirds peak in early May. During fall migration, the analysis found that waterbirds tended to peak early, whereas landbird numbers were more stable over time.

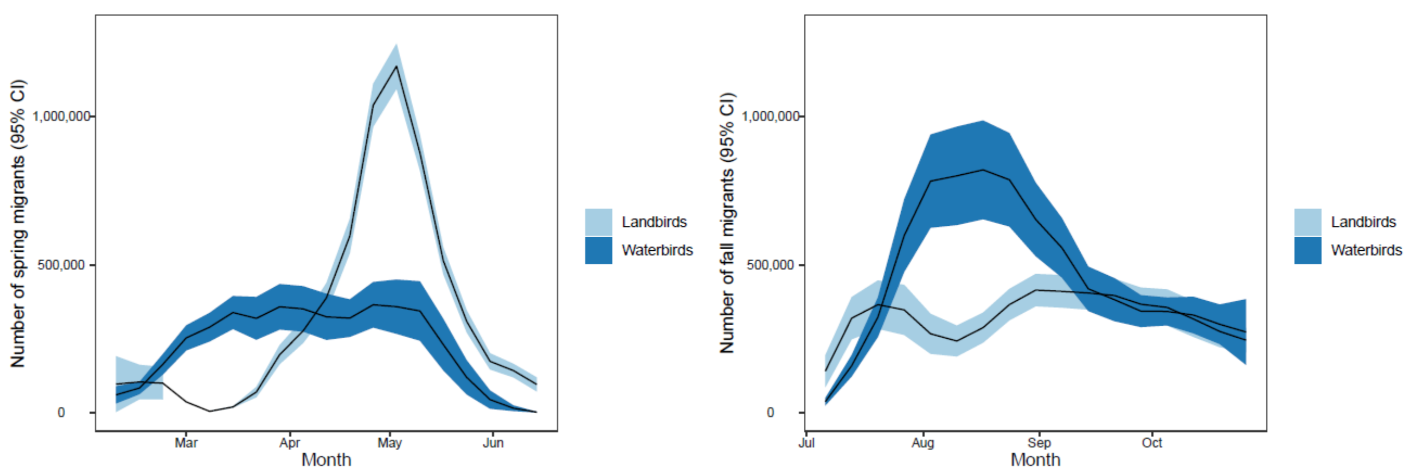

Figure 3, Line graphs showing the estimated number of landbirds and waterbirds using the Yazoo Backwater Area in each week of the spring and fall migration seasons. The colored ribbon in Figure 3 represents a 95% confidence intervals around those estimates. Source: The findings were based on

[4] Clean Water Act 404(c) Final Determination Appendix 2 “Yazoo Backwater Area Faunal Species Lists”.

analyses by the National Audubon Society, using data from eBird Status & Trends from the Cornell Lab of Ornithology and Partners in Flight Population Estimates Database from Bird Conservancy of the Rockies

The analysis illustrates the total number landbird and waterbird species within each of four categories to summarize the proportion of species' North American breeding population that use the Yazoo Backwater Area during spring and fall migrations (see Figures 4 and 5, below). To provide population-level importance of the Yazoo Backwater Area to migrating species, Audubon used BirdLife International's Global Important Bird Area criteria A4, which allows a site to qualify as globally significant if it regularly holds congregations of ≥1% of the global population of one or more species. Any species in either the low, moderate, or high categories meets this ≥1% criterion. The delineation of the four categories are as follows: **below 1%** – greater than zero but less than 1% of the species population uses the site; **low** – the percent of species populations that use the site is ≥ 1% but within the bottom third of the data range; **moderate** – the percent of species populations that use the site is in the middle third of the data range; **high** – the percent of species populations that use the site is in the upper third of the data range.

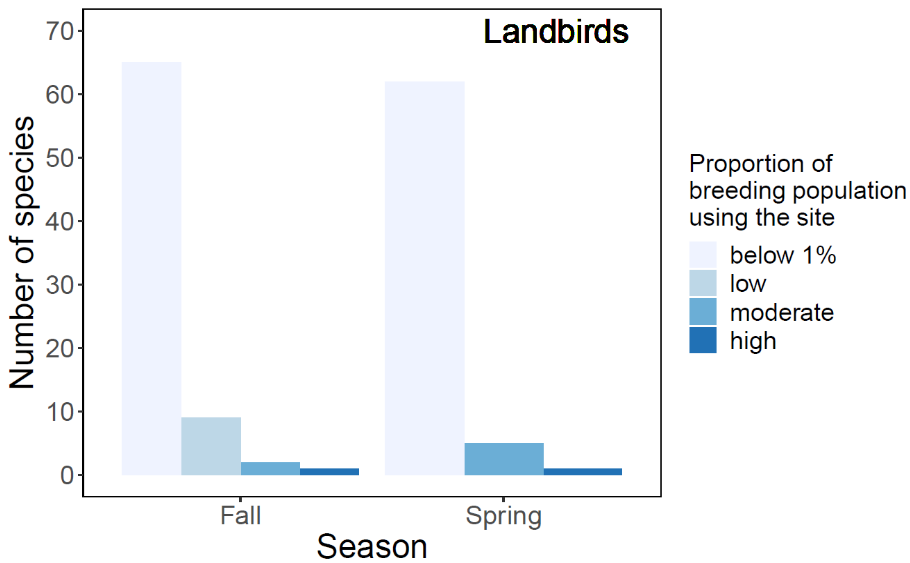

Figure 4, The proportion of the total North American population of landbirds that migrate through the Yazoo Backwater Area during fall and spring. Source: The findings were based on analyses by the National Audubon Society, using data from eBird Status & Trends from the Cornell Lab of Ornithology and Partners in Flight Population Estimates Database from Bird Conservancy of the Rockies

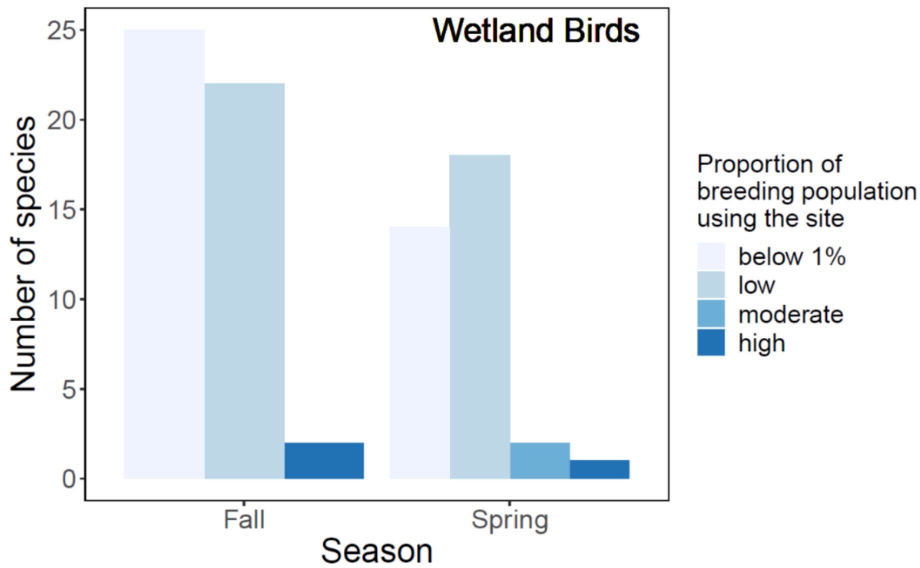

Figure 5, The proportion of the total North American population of waterbirds that migrate through the Yazoo Backwater Area during fall and spring. *Source: The findings were based on analyses by the National Audubon Society, using data from eBird Status & Trends from the Cornell Lab of Ornithology and Partners in Flight Population Estimates Database from Bird Conservancy of the Rockies*

In comparing these results to the Species of Greatest Conservation Need (SGCN) identified in Mississippi's State Wildlife Action Plan[5], there were nine SGCN species that trigger the ≥1% continental population threshold for either spring or fall migration through the Yazoo Backwater Area. These were:

- Dunlin (spring)
- Interior Least Tern (fall, Endangered Species Act listed)
- Lesser Scaup (spring)
- Peregrine Falcon (fall)
- Prothonotary Warbler (spring) (see Figure 6, below)
- Snowy Egret (fall)
- Tricolored Heron (fall)
- Western Sandpiper (fall)
- Yellow-crowned Night-Heron (spring and fall)

For example, the analysis found that nearly 21,000 Prothonotary Warblers use the Yazoo Backwater Area during spring migration. Upon comparing this estimate of Prothonotary Warbler numbers during peak spring migration to the estimate of what proportion of the species' global population that represents; the Yazoo Backwater Area supports almost 1% of the species' total global population.

The life-cycle of this cavity-nesting species is highly dependent on rivers and bottomland hardwood forests, resulting in it being common throughout the Mississippi River Flyway.[6] However, the species is

[5] Mississippi Museum of Natural Science (2014). *Endangered Species of Mississippi.* Mississippi Department of Wildlife, Fisheries, & Parks, Mississippi Museum of Natural Science, Jackson, MS *(available at https://www.mdwfp.com/media/3231/endangered_species_of_mississippi.pdf)* (visited June 10, 2020).
[6] Cornell Lab of Ornithology, All About Birds website, https://www.allaboutbirds.org/guide/Prothonotary_Warbler/overview (visited November 18, 2020).

experiencing a significant population decline because of the loss of forested wetlands in the United States and mangroves on its wintering grounds.

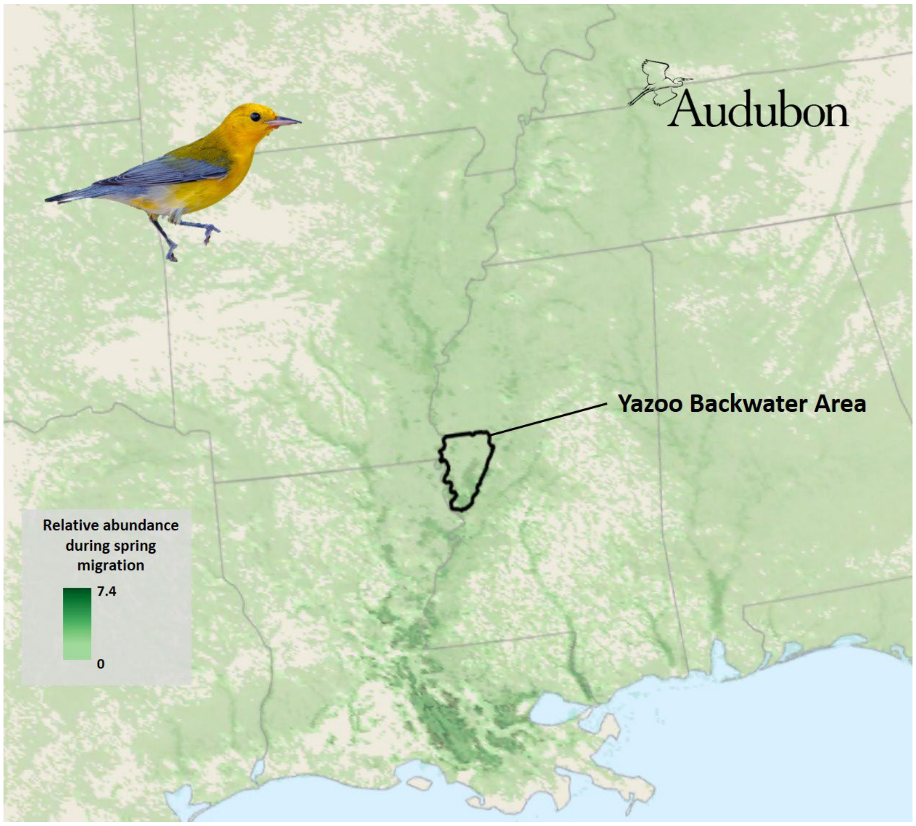

Figure 6, This map shows the relative abundance of Prothonotary Warblers using the Yazoo Backwater Area across the entire spring migration season. Up to nearly 21,000 Prothonotary Warblers use the Yazoo Backwater Area during spring migration. This represents almost 1% of the species' total global population. Source: The findings were based on analyses by the National Audubon Society, using data from eBird Status & Trends /Cornell Lab of Ornithology and Partners in Flight Population Estimates Database/Bird Conservancy of the Rockies. Photo by Lorraine Minns/Audubon Photography Awards

Also, the analysis identified 12 bird species that exceeded the 10% continental population threshold for spring and/or fall migration through the Yazoo Backwater Area:

- American Golden-Plover (spring)
- Blue-winged Teal (spring and fall)
- Greater White-fronted Goose (fall)
- Least Sandpiper (spring and fall)
- Lesser Yellowlegs (spring and fall)
- Long-billed Dowitcher (fall)
- Pectoral Sandpiper (spring and fall) (see Figure 7, below)
- Roseate Spoonbill (fall)
- Semipalmated Sandpiper (fall)
- Snowy Egret (fall)

- Stilt Sandpiper (spring and fall)
- White-rumped Sandpiper (spring)

EPA has acknowledged that, "If the frequency of spring flooding in the Yazoo Backwater Area is significantly reduced, then the loss of this seasonal habitat would result in lower survival rates, and therefore, reduced northward shorebird migrations." [7] EPA highlighted the importance of the project area's shallowly flooded wetlands as prime spring migration stopover habitat, especially for Pectoral Sandpipers. This shorebird often nests in the Arctic Tundra and winters in southern South America, resulting in a round-trip migration of nearly 19,000 miles every year.[8] The population of Pectoral Sandpipers is in decline and the species is on the Partners in Flight Yellow Watch List.

Audubon's abundance analysis found that significant numbers of Pectoral Sandpipers migrate through the Yazoo Backwater Area annually, especially in the fall. The analysis found that up to nearly 500,000 Pectoral Sandpipers use the project area during one week of peak fall migration, or about 30% of the species' total global population. Audubon's findings on Pectoral Sandpipers profoundly demonstrate the hemispheric importance of the Yazoo Backwater habitats to the global population health of this species, thereby reinforcing the serious threat the Yazoo Pumps pose to this and many other migrating species.

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[7] Clean Water Act 404(c) Final Determination at 58.
[8] Cornell Lab of Ornithology, All About Birds website, https://www.allaboutbirds.org/guide/Pectoral_Sandpiper/overview (visited November 18, 2020).

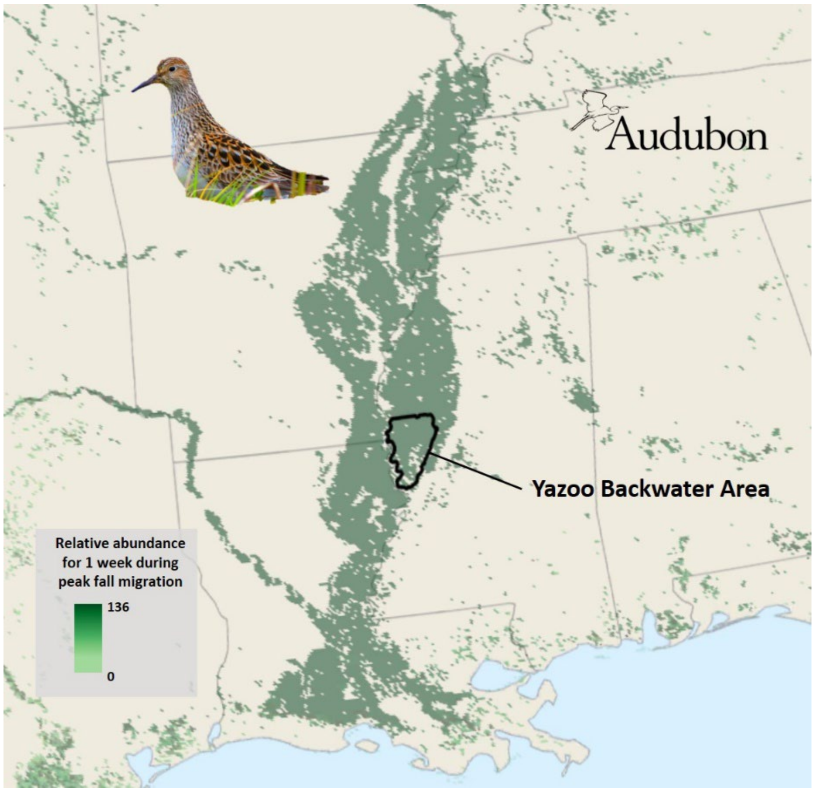

Figure 7, This map shows an example week during peak fall migration for Pectoral Sandpipers using the Yazoo Backwater Area. Up to nearly 500,000 Pectoral Sandpipers use the Yazoo Backwater Area during 1 week of peak fall migration. The Yazoo Backwater was found to support almost 30% of their global population. Source: The findings were based on analyses by the National Audubon Society, using data from eBird Status & Trends/Cornell Lab of Ornithology and Partners in Flight Population Estimates Database/Bird Conservancy of the Rockies. Photo by Jamie Lyons/Audubon Photography Awards

Additionally, Audubon performed an overwintering waterfowl analysis to determine 17 species' use of the Yazoo Backwater Area during the period of December-February. The results found more than 6.3 million of these 17 waterfowl species[9] were estimated to use the area during the winter (see Figure 8, below). This represents 8% of their total North American population with the most notable use by Greater White-fronted Geese and Snow Geese, at 17.6% and 32.1%, respectively, of their North American population (see Figures 9 and 10, below).

Applying BirdLife International's Global Important Bird Area criteria A4 discussed earlier, 7 of the 17 species modeled were found to meet or exceed the ≥1% continental population threshold for overwintering in the Yazoo Backwater Area:

- Gadwall
- Greater White-fronted Goose (see Figure 9, below)
- Green-winged Teal
- Mallard (see Figure 11, below)

[9] The 17 waterfowl species modeled were American Wigeon, Blue-winged Teal, Bufflehead, Canada Goose, Canvasback, Gadwall, Greater White-fronted Goose, Green-winged Teal, Hooded Merganser, Lesser Scaup, Mallard, Northern Pintail, Northern Shoveler, Ring-necked Duck, Ruddy Duck, Snow Goose, and Wood Duck.

- Northern Shoveler
- Short-billed Dowitcher
- Snow Goose (see Figure 10, below)

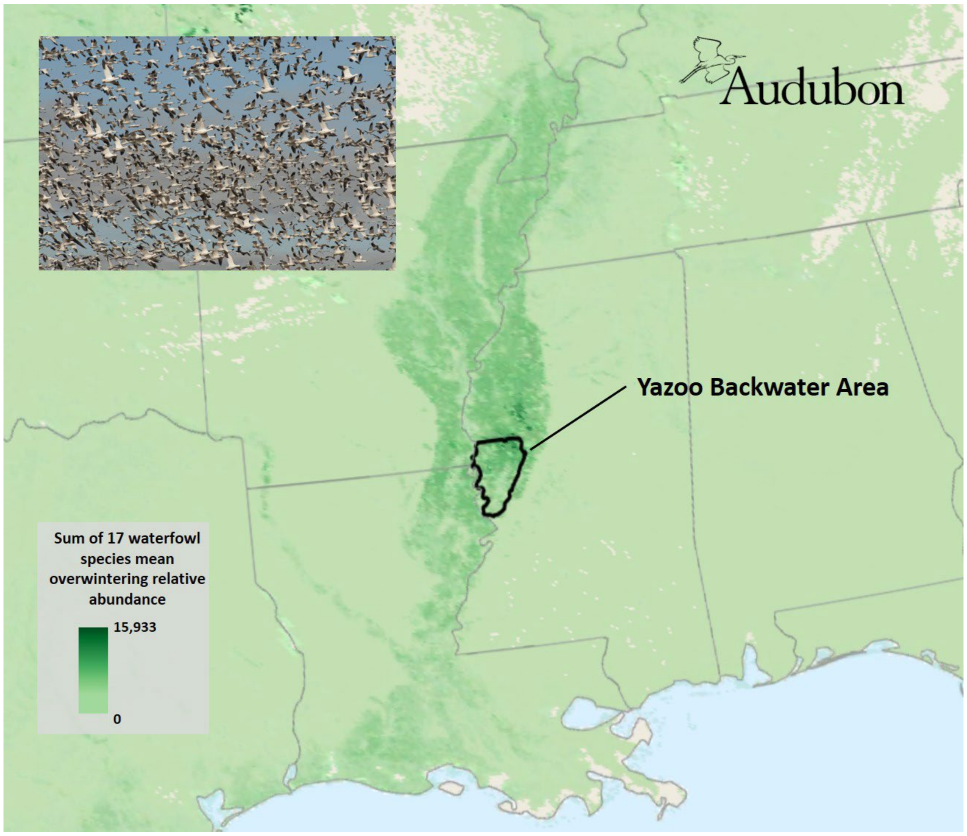

Figure 8, This map shows the total relative abundance of 17 waterfowl species using the Yazoo Backwater Area from December-February. Annually, more than 6.3 million of these species were estimated to overwinter in the area. Source: The findings were based on analyses by the National Audubon Society, using data from eBird Status & Trends /Cornell Lab of Ornithology and Partners in Flight Population Estimates Database/Bird Conservancy of the Rockies. Photo credit: Walker Golder / National Audubon Society

These waterfowl abundance results reinforce the significance of the Yazoo Backwater Area as a key ecologic lynchpin of the LMRAV, particularly in providing important wintering habitat for waterfowl. Audubon's analysis found that nearly 137,000 Mallards overwinter in the project area, or 1.2% of their global population, and six other species modeled also met or exceeded the ≥1% continental population threshold for overwintering in the Yazoo Backwater Area (see Figure 11, below).

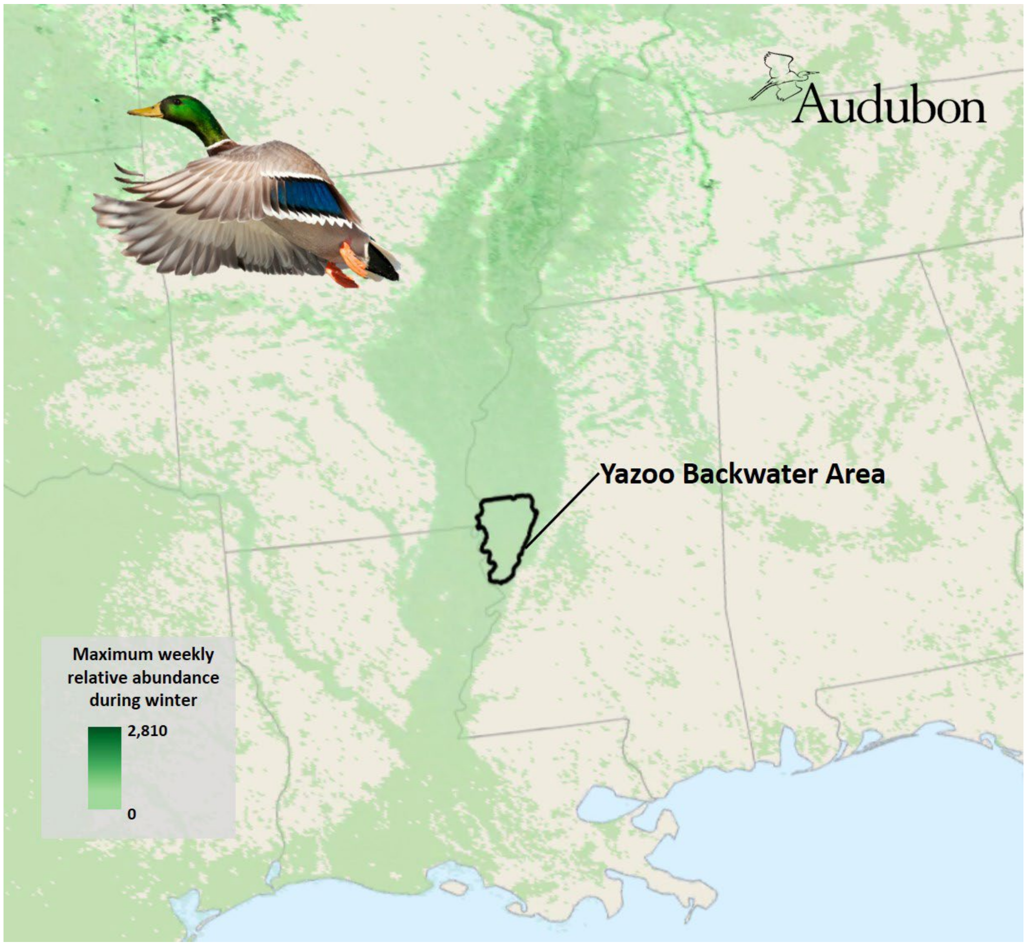

Figure 11, This map shows the maximum weekly relative abundance of Mallards using the Yazoo Backwater Area from December-February. Nearly 137,000 Mallards were estimated to overwinter in the area, which represents over 1.2% of their global population. Source: The findings were based on analyses by the National Audubon Society, using data from eBird Status & Trends /Cornell Lab of Ornithology and Partners in Flight Population Estimates Database/Bird Conservancy of the Rockies. Photo credit: Robert Bunch / Audubon Photography Awards

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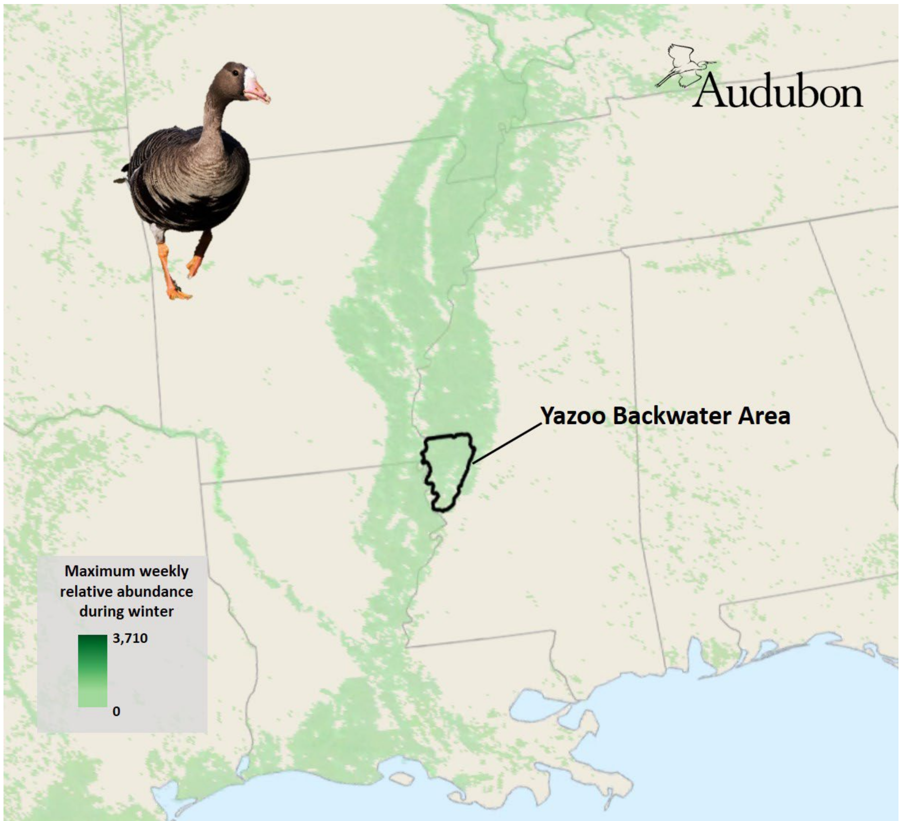

Figure 9, This map shows the maximum weekly relative abundance of Greater White-fronted Geese using the Yazoo Backwater Area from December-February. Over 600,000 Greater White-fronted Geese were estimated to overwinter in the area, which represents 17.6% of their global population. Source: The findings were based on analyses by the National Audubon Society, using data from eBird Status & Trends /Cornell Lab of Ornithology and Partners in Flight Population Estimates Database/Bird Conservancy of the Rockies. Photo credit: Lou Orr/Great Backyard Bird Count

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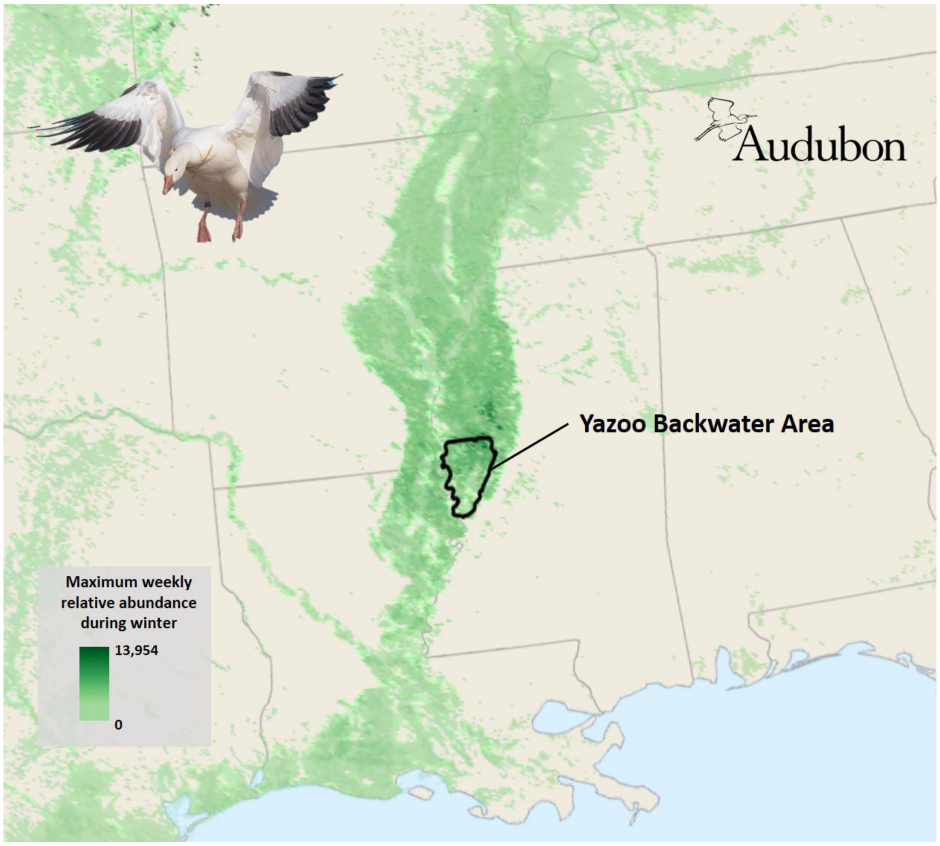

Figure 10, This map shows the maximum weekly relative abundance of Snow Geese using the Yazoo Backwater Area from December-February. Nearly 5 million Snow Geese were estimated to overwinter in the area, which represents over 32% of their global population. Source: The findings were based on analyses by the National Audubon Society, using data from eBird Status & Trends /Cornell Lab of Ornithology and Partners in Flight Population Estimates Database/Bird Conservancy of the Rockies. Photo credit: Jamie Lyons / Audubon Photography Awards

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From: Melissa Samet <sametm@nwf.org>
Sent: Tuesday, August 27, 2024 6:25 PM
To: YazooBackwater MVK
Subject: [Non-DoD Source] Conservation Organization Yazoo Pumps Comments: Email 3 of 4
Attachments: Conservation Organization Comments_Yazoo Pumps DEIS_Attachment F.pdf

Importance: High

Please see attachments F to the comments on the Yazoo Pumps Draft EIS from the National Wildlife Federation, National Audubon Society, Sierra Club, Audubon Delta, Healthy Gulf, and Mississippi Chapter of the Sierra Club.

Due to the large file size of the attachments, I am sending the text of the comments and the Attachments in 4 separate emails. This is email 3 of 4.

I would very much appreciate you confirming receipt of each of the 4 emails.

Thank you.

Melissa Samet
Legal Director, Water Resources and Coasts
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Attachment F

Comments on the Draft Environmental Impact Statement for the Yazoo Backwater Area Water Management Project, June 2024

Submitted by

National Wildlife Federation, National Audubon Society, Sierra Club
Audubon Delta, Healthy Gulf, Sierra Club Mississippi

August 27, 2024

Restoration Ecology
THE JOURNAL OF THE SOCIETY FOR ECOLOGICAL RESTORATION

SHORT COMMUNICATION

Temporary connectivity: the relative benefits of large river floodplain inundation in the lower Mississippi River

Quinton E. Phelps[1,2,3], Sara J. Tripp[1], David P. Herzog[1], James E. Garvey[4]

Studies have demonstrated the importance of the synergistic relationship between large rivers and adjacent floodplain connectivity. The majority of large rivers and their associated floodplain have been isolated through a series of expansive levee systems. Thus, evaluations of the relative importance of floodplain connectivity are limited due to the aforementioned anthropogenic perturbations. However, persistent elevated river levels during spring 2011 at the confluence of the Mississippi River and Ohio River prompted the U.S. Army Corps of Engineers to create large gaps in the levee system producing an expansive floodplain (i.e. the New Madrid Floodway). Specifically, the New Madrid Floodway (approximately 475 km^2) in southeast Missouri was created to divert part of the Mississippi River flow during catastrophic floods and thus alleviate flood risk on nearby population centers. Given the historic flooding of 2011, the floodway was opened and provided an unprecedented opportunity to evaluate the influence of floodplain inundation on fish species diversity, relative abundance, and growth. We sampled the floodplain and the adjacent river at three stratified random locations with replication biweekly from the commencement of inundation (late May) through early October. Overall, we found that species diversity, relative abundance, and growth were higher in the floodplain than the main river. Our data support previous examinations, including those outside North America, that suggest floodplain inundation may be important for riverine fishes. Given these apparent advantages of floodplain inundation, restoration efforts should balance benefits of floodplain inundation while safeguarding priority needs of humans.

Key words: channel catfish, fish diversity, floodplain connectivity, floodplain restoration, freshwater drum, gizzard shad, silver carp

Implications for Practice

- Inundation of the floodplain may increase species diversity of the riverine ecosystem.
- Higher abundance and faster growth in the floodplain may lead to higher production, a well-defined measure of ecosystem function, as opposed to their less numerous slower growing main river conspecifics. Regardless of the fate (e.g. recruit to the population or become stranded) of the fishes on the floodplain an important energetic link in the overall food web exists. We suggest future investigations determine the mechanisms (e.g. potential increased forage base or reduced energy costs) initiating the increased abundance and faster growth in the floodplain.
- Extensive collaboration by river managers and stakeholders addressing benefits of floodplain connectivity, to ensure a balance between human users and native biota, should be pursued as part of floodplain reconnection strategies.

Introduction

Throughout the world, dam construction, levee creation, and channelization have altered synergistic processes and interactions between rivers and associated floodplains (Petts 1989; Bayley 1991; Nilsson et al. 2005). These modifications deleteriously influence native fishes that may depend on floodplain habitats (Bayley 1991; Trexler 1995). Many large river fishes exhibit migratory behaviors and life-history attributes to take advantage of seasonally predictable flood events (Petts 1989). Flooding increases habitat availability and energy sources (Welcomme 1979; Winemiller & Rose 1992). Prior to disturbance, large river fishes using floodplain habitats were a common occurrence throughout the world (Welcomme 1979; Petts 1989; Winemiller & Rose 1992) but have since been impeded. Large river fish communities that are capable of utilizing off-channel habitats may exhibit increased diversity,

Author contributions: QP, ST, DH, JG conceived and designed the research; QP, ST, DH collected the data from the field; QP, ST, DH, JG analyzed the data; DH, JG provided materials/analysis tools; QP, ST, DH, JG wrote and edited the manuscript.

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doi: 10.1111/rec.12119

high abundance, and fast growth (Gutreuter et al. 1999; Theiling et al. 1999).

Despite extensive efforts to control the Mississippi River through many modifications, excessive water levels during late May through early October 2011 caused the U.S. Army Corps of Engineers to create a gap in the Mississippi River main line levee. This process inundated the historic floodplain and ultimately reduced flood risk on nearby population centers (USACE 2011). Given reported benefits of floodplain connectivity noted above, we hypothesized similar biotic benefits within the floodplain of the lower Mississippi River. Thus, we compared species diversity, relative abundance, and growth between the floodplain and the adjacent main river. Ultimately, these data have provided additional insight into floodplain connectivity, the relative influence on large river fishes, and potential recommendations for floodplain restoration.

Methods

The New Madrid Floodway (−89.126308 longitude, 36.975898 latitude) in southeast Missouri was created to divert part of the lower Mississippi River flow during catastrophic floods and thus alleviate flood risk on nearby population centers (USACE 2011). Since its creation, it was opened once during the extreme 1937 flood (USACE 2011). During 2011, the floodway was again opened and provided an unprecedented opportunity to evaluate the influence of floodplain inundation on fishes. Sampling commenced in late May and ended in early October. At approximately 2-week intervals, we randomly sampled across strata (Fig. 1) at five off-channel locations with electrofishing and five channel margins with bottom trawling in the floodway and main river. Thus, both the floodplain and main river were sampled with the same sampling gear and sampling effort. In some instances, sampling locations were inaccessible (e.g. safety); thus, we sampled other available randomly selected locations.

All fishes were identified and enumerated. Shannon–Wiener index (MacArthur & MacArthur 1961) was used to compare diversity between the floodway and adjacent river. We used mean Shannon–Wiener diversity index and standard errors to make comparisons. For comparing density (via relative abundance) of the most dominant species between the floodway and adjacent river, we calculated standardized catch per unit effort (SCPUE) using number of fish captured per minute trawled or electrofished (Phelps et al. 2009). Growth (tissue increase) was assessed by following cohorts of the most dominant species over the course of our evaluation (Braaten & Fuller 2007; Phelps et al. 2010). Growth was evaluated by merging similar sized fishes into their respective conspecific cohorts over time. Specifically, we followed conspecific cohorts over time through length-frequency analyses. We used mean length of each designated conspecific cohort and regressed this against sampling date to determine a cohort-specific growth rate (mm/day). Using growth rates for each individual cohort, we then calculated mean growth rate for fishes collected in the floodplain and adjacent main river. Comparisons of relative abundance (i.e. SCPUE) and growth were assessed between locations using two-sample t tests.

Figure 1. The New Madrid Floodway extends from Birds Point, Missouri south to New Madrid, Missouri and encompasses the area between the Birds Point-New Madrid secondary levee and the Mississippi River primary levee (approximately 475 km^2 inundated). Prior to development, the New Madrid Floodway was dominated by bottomland hardwoods that periodically provided aquatic habitats used by fishes. This area has subsequently been cleared for agriculture related uses. Graphic depicts locations of gaps (*) in main-line levee created by the U.S. Army Corps of Engineers to inundate floodplain during 2011. Sampling locations were stratified within the upper, middle, and lower portions (transparent circles) of the floodway and adjacent main river.

Results

Over the course of our evaluation, a total of 82 species were collected from combined samples from the floodplain and adjacent main river (Table 1). The majority of the fishes were captured in the floodway constituting a total of 14,276 fishes representing 77 species (Table 1). On the basis of these catches, the floodplain Shannon–Wiener diversity index was 2.31 (SE = 0.09). In the adjacent main river, we captured 4,766 fishes consisting of 59 species (Table 1) and the Shannon–Wiener diversity index was 1.99 (SE = 0.13). Furthermore, the dominant species captured within the floodplain and the adjacent main river were gizzard shad (*Dorosoma cepidianum*), silver carp (*Hypoptholmichtys molitrix*), freshwater drum (*Aplodinotus grunniens*), and channel catfish (*Ictaluras punctatus*). In terms of the above most dominant taxa, the floodplain generally had higher abundance estimates than those derived from the adjacent main river (Table 2; most comparisons $p < 0.05$). Furthermore, the majority of the most dominant species listed above exhibited faster growth rates in the floodplain relative to the main river (Table 3; $p < 0.05$); except silver carp, which exhibited similar growth rates regardless of location (Table 3; $p > 0.05$)

Discussion

Floodplain rivers are one of the most productive landscapes in the world because of nutrient additions associated with ingression and retention of water (Tockner & Stanford 2002).

Table 1. Fish species (scientific names) list of collected during 2011 using both electrofishing and trawling in the New Madrid Floodway and the adjacent main river.[a]

Species	*Floodway*	*River*	*Species*	*Floodway*	*River*
Polyodon spathula	*	*	*Ameiurus melas*	*	*
Scaphirhynchus platorynchus	*	*	*Ictalurus furcatus*	*	*
Lepisosteus oculatus	*	*	*Ictalurus punctatus*	*	*
Lepisosteus osseus	*	*	*Noturus gyrinus*	*	*
Lepisosteus platostomus	*	*	*Noturus nocturnus*	*	*
Amia calva	*	*	*Pylodictus olivaris*	*	*
Angui1lla rostrata	NA	*	*Aphredoderus sayanus*	*	NA
Alosa chrysochloris	*	*	*Labidesthes sicculus*	*	*
Dorosoma petenense	*	*	*Menidia beryllina*	*	NA
Dorosoma cepedianum	*	*	*Fundulus notatus*	*	*
Hiodon alosoides	*	*	*Gambusia affinis*	*	NA
Hiodon tergisus	*	*	*Elassoma zonatum*	*	NA
Esox americanus	*	NA	*Centrarchus macropterus*	*	NA
Esox niger	*	NA	*Lepomis cyanellus*	*	*
Ctenopharyngodon idella	*	*	*Lepomis gulosus*	*	*
Cyprinella lutrensis	*	*	*Lepomis humilis*	*	*
Cyprinella venusta	*	*	*Lepomis macrochirus*	*	*
Cyprinus carpio	*	*	*Lepomis megalotis*	*	*
Hybognathus nuchalis	*	NA	*Lepomis microlophus*	*	*
Hypophthalmichthys molitrix	*	*	*Lepomis miniatus*	*	*
Macrhybopsis aestivalis	NA	*	*Lepomis* spp. hybrid	*	NA
Macrhybopsis meeki	*	*	*Micropterus punctulatus*	*	*
Macrhybopsis storeriana	*	*	*Micropterus salmoides*	*	*
Notemigonus crysoleucas	*	*	*Pomoxis annularis*	*	*
Notropis atherinoides	*	*	*Pomoxis nigromaculatus*	*	*
Notropis blennius	*	*	*Etheostoma asprigene*	*	NA
Notropis maculatus	*	NA	*Etheostoma caeruleum*	*	NA
Notropis shumardi	*	*	*Etheostoma chlorosoma*	*	NA
Notropis stramineus	*	NA	*Etheostoma gracile*	*	NA
Notropis wickliffi	*	*	*Etheostoma histrio*	NA	*
Opsopoeodus emiliae	*	*	*Etheostoma nigrum*	*	NA
Pimephales notatus	*	*	*Etheostoma proeliare*	*	NA
Pimephales vigilax	*	*	*Etheostoma spectabile*	*	NA
Carpiodes carpio	*	*	*Percina caprodes*	*	*
Carpiodes cyprinus	*	NA	*Percina sciera*	*	*
Cycleptus elongates	*	*	*Percina shumardi*	NA	*
Erimyzon sucetta	*	NA	*Percina vigil*	*	NA
Ictiobus babulus	*	*	*Sander canadensis*	*	*
Ictiobus cyprinellus	*	*	*Aplodinotus grunniens*	*	*
Ictiobus niger	*	*	*Morone chrysops*	*	*
Moxostoma macrolepidotum	*	NA	*Morone mississippiensis*	*	NA

[a]Note: '*' indicates the species was collected, while NA indicates the species was not collected. Species are sorted by taxonomic order.

Table 2. Mean SCPUE (using both electrofishing and trawling) and standard error (in parentheses) as a measure of relative abundance (number per minute) of the four most common species collected during 2011 in the New Madrid Floodway and the adjacent main river.

Species	*Floodway*	*Main River*	*Statistical Test*	*DF*
Gizzard Shad	14.39 (4.18)	0.81 (0.19)	*	224
Silver Carp	4.13 (2.16)	3.81 (2.42)	NS	224
Freshwater Drum	6.89 (2.95)	0.56 (0.19)	*	224
Channel Catfish	0.14 (0.85)	1.73 (1.09)	*	224

Two-sample t test were used to make comparisons between the floodway and the main river. Asterisk indicates $p < 0.05$, while NS indicates $p > 0.05$.

Table 3. Mean daily growth rate (mm/day) and standard error (in parentheses) of the four most common species collected during 2011 in the New Madrid Floodway and the adjacent main river.

Species	*Floodway*	*Main River*	*Statistic*	*DF*
Gizzard Shad	2.85 (0.04)	1.42 (0.01)	*	6129
Silver Carp	2.5 (0.07)	2.5 (0.10)	NS	2408
Freshwater Drum	1.49 (0.09)	0.95 (0.06)	*	1984
Channel Catfish	0.72 (0.03)	0.46 (0.01)	*	643

Two-sample t test were used to make comparisons between the floodway and the main river. Asterisk indicates $p < 0.05$, while NS indicates $p > 0.05$.

Lateral connectivity creates multiple lentic and lotic aquatic habitat environments. Thus, inundation of floodplain increases productivity and habitat availability accessible to fishes (Welcomme 1979; Winemiller & Rose 1992; Nilsson et al. 2005). Increase in habitat availability associated with floodplain has been reported to increase fish species diversity and abundance (Theiling et al. 1999). Gutreuter et al. (1999) found that off-channel habitat connectivity during periods of flooding was related to increased growth of some species within the Upper Mississippi River. Similarly, Sommer et al. (2001) studied the Sacramento River and noted that juvenile salmon exhibited greater growth in the floodplain relative to the main river.

Overall, we have demonstrated that inundation of the Mississippi River floodplain increased species diversity, relative abundance, and growth of some dominant fish species. Thus, these biotic benefits of floodplain connectivity are extremely important to riverine fishes. However, these areas are considered one of the most imperiled ecosystems in the world (Welcomme 1979; Nilsson et al. 2005), principally owed to human activities. Thus, conservation strategies or restoration approaches that attempt to reestablish connectivity are paramount to restoring large floodplain rivers and the associated biota worldwide. Because large floodplain rivers are prone to infrequent, major floods, restoration practitioners should anticipate such floods by creating large floodways that can be activated when necessary, thereby producing a win–win outcome of improving the ecological function of large, floodplain rivers while at the same time mitigating negative impacts of catastrophic floods on humans.

Acknowledgments

This study was funded by the U.S. Army Corps of Engineers' Upper Mississippi River Restoration—Environmental Management Program's Long Term Resource Monitoring component implemented by the U.S. Geological Surveys' Upper Midwest Environment Sciences Center, in cooperation with the Missouri Department of Conservation.

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Coordinating Editor: Robin DeBruyne

Received: 6 October, 2013; First decision: 15 November, 2013; Revised: 18 March, 2014; Accepted: 19 March, 2014; First published online: 16 July, 2014

North American Journal of Fisheries Management

ISSN: 0275-5947 print / 1548-8675 online
DOI: 10.1002/nafm.10435

SPECIAL SECTION: 4TH MISSISSIPPI–YANGTZE RIVER BASINS SYMPOSIUM

Black Bass Growth Patterns in Relation to Hydrology in the Arkansas River, Arkansas

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Abstract

Hydrology has been documented as affecting the recruitment of sport fishes. However, the potential cumulative effects of river hydrology on fish growth have not been intensively studied. In 2004, 2005, and 2010, annual growth increments were measured for Largemouth Bass *Micropterus salmoides* and Spotted Bass *M. punctulatus* populations from throughout the Arkansas portion of the Arkansas River. During three consecutive years (2007–2009), the lower Arkansas River experienced long durations of high water. Mean annual flows exceeded the 42-year average by 52%, with summer flows averaging 107% above normal and 29% of the days annually exceeding 2,830 m^3/s. Using age-1–6 cohorts, we compared Largemouth Bass ($n = 2,155$) and Spotted Bass ($n = 833$) growth increments across hydrologic conditions occurring during the growth years experienced by these fish. Two-way ANOVAs using back-calculated age and growth year warm-season hydrology (classified as high, average, or low flow based on quartiles from historical April–September hydrographs) as main effects suggested significant hydrologic effects on the growth of both black bass species. A significant interaction between back-calculated age and growth year April–September hydrology for both black basses further suggested that flow affected growth differently across ages, with decreased annual growth increments detected for the age-1–3 cohorts. Decreased annual growth occurring during 2007–2009 also was consistent with a 0.5-year increase in the age at which Largemouth Bass attained 381 mm TL (i.e., the minimum length required for legal harvest) in 2010. Similarly, Spotted Bass required an extra 0.9 year to attain 304 mm TL (i.e., a common minimum length limit). Results suggested that the typically beneficial effects of high-flow years on black bass populations in large-river–floodplain systems may be dampened or non-existent in more highly regulated, impounded river systems, such as the modern-day Arkansas River.

Many aspects of fisheries have been directly related to various hydrological characteristics in many types of aquatic systems. Based on contemporary theory, the ecology of floodplain rivers is heavily linked to hydrology in that floodplain inundation from predictable annual flood pulses fuels the reproductive success, growth, and production of many riverine fishes (e.g., Junk et al. 1989; Lorenz et al. 1997). In lakes and reservoirs, high water levels coinciding with fish spawning are often associated with strong year-classes for many fishes (Sammons and Bettoli 2000; Dutterer et al. 2013). In these cases, high water is linked to both spawning and recruitment success for fishes (Sammons and Bettoli 2000; Dutterer et al. 2013; Siepker and Michaletz 2013), including several popular U.S. sport fishes.

Seasonal increases and variation in hydrology serve many ecological purposes for fishes (Poff and Allan 1995). Increased seasonal flows often serve as cues for spawning

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Received October 11, 2019; accepted March 6, 2020

and migration for many fishes while also affecting the quality and quantity of available habitats in aquatic systems (Poff et al. 1997). Many of these habitats are linked to life history completion for certain species (Junk et al. 1989). On the other hand, years with "extreme" or otherwise above-average hydrology in terms of magnitude and duration have the potential to disrupt fish nesting and spawning and to induce direct mortality of eggs, larvae, and juveniles (Lytle and Poff 2004; Poff and Zimmerman 2010). Furthermore, these processes may be influenced both positively and negatively by the extensive anthropogenic modifications that have occurred in most modern-day river systems (e.g., dams, levees, channelization, and floodplain reductions).

The Largemouth Bass *Micropterus salmoides* is the primary sport fishery in many southern U.S. waters; thus, a better understanding of fish–hydrology relationships for this species would be especially valuable toward management. In most systems, Largemouth Bass have been strongly associated with the low-current habitats that are needed to successfully reproduce, feed, rear young, and overwinter (Raibley et al. 1997). Maceina and Bettoli (1998) reported that Largemouth Bass recruitment in four main-stem reservoirs on the Tennessee River was inversely related to early summer hydrology. Limbird and Leone (2009) reported a striking inverse relationship between Largemouth Bass abundance and the previous year's mean flow in Lake Dardanelle on the Arkansas River (Figure 1). When examining Largemouth Bass in the context of hydrology, previous research has focused more on links between hydrology and measures of reproductive success or juvenile survival —both of which affect future year-class strengths (e.g., Maceina and Bettoli 1998; Sammons and Bettoli 2000; Siepker and Michaletz 2013). For the Spotted Bass *M. punctulatus*, less research has been done. However, Sammons and Bettoli (2000) were unable to detect relationships between Spotted Bass recruitment and hydrology in a Tennessee tributary reservoir despite observing significant relationships for other species.

Few studies have evaluated the effects that hydrology may have on black bass growth, which also influences future year-class strength. Maceina and Bettoli (1998) speculated that weak Largemouth Bass year-classes in Tennessee River reservoirs were associated with years of higher flow. Although Largemouth Bass growth was not reported, they postulated that depressed juvenile survival occurred in response to lower prey fish production during high-flow years, especially during years when high water extended through early summer. A lack of forage would undoubtedly affect the first-year growth of juvenile Largemouth Bass, which has been linked to rates of overwinter survival and eventual year-class strength in other studies (e.g., Adams and DeAngelis 1987; Maceina and Bettoli 1998). Raibley et al. (1997) reported compelling evidence of differential size distributions of Largemouth Bass that appeared to vary with annual hydrologic regimes over several years in the Illinois River. Dutterer et al. (2013) observed greater growth of age-0 Largemouth Bass coincident with greater spring–summer flows in the Apalachicola River, Florida. Conversely, Earley and Sammons (2018) could not detect strong growth–flow relationships for Alabama Bass *M. henshalli* or Redeye Bass *M. coosae* in an Alabama river that experienced hydropeaking operations. Although not well researched, there are indications of links between hydrology and black bass growth in some systems.

The goal of this study was to quantify possible fish growth–hydrology relationships in the lower Arkansas River, Arkansas, across years of variable hydrology. Focus was placed on the two native black basses: the Largemouth Bass and Spotted Bass (hereafter collectively referred to as "black bass"). The objectives of this study were to (1) quantify black bass age and growth from large samples taken throughout the lower Arkansas River and (2) examine possible relationships between black bass growth and river hydrology. Given that hydrology can be a dominant factor affecting fisheries in main-stem reservoir systems (Maceina and Bettoli 1998; Quinn and Limbird 2008), results of this study will help to better refine fish–hydrology relationships for both species. Increased understanding of these relationships could assist fisheries managers not only in developing more appropriate regulations but also in conducting environmental planning efforts.

METHODS

Study area.— Our study area included the impounded lower Arkansas River within the state of Arkansas. This area encompassed 472 km of river channel and associated off-channel habitats beginning in western Arkansas at Ft. Smith (Pool 13) and ending at Lake Merrisach in the Arkansas Post Canal (lower end of Pool 2 adjacent to the White and Mississippi rivers). This reach of the Arkansas River is contained entirely within the McClellan–Kerr Arkansas River Navigation System (MKARNS), which is a serial lock-and-dam system comprised of 11 navigation pools in Arkansas ranging in size from 1,500 to 11,000 ha (Eggleton et al. 2011). With the exception of the downstream portion of Pool 10 (Lake Dardanelle), navigation pools within the MKARNS typify "run-of-the-river" reservoirs, with main-channel habitat averaging 66% (range = 58–82%) of the total aquatic habitat in each pool (Schramm et al. 2008). The navigation system was constructed with numerous dike fields and revetments in order to constrict flow and induce channel scouring (Quinn and Limbird 2008), which in turn created short (<1-week)

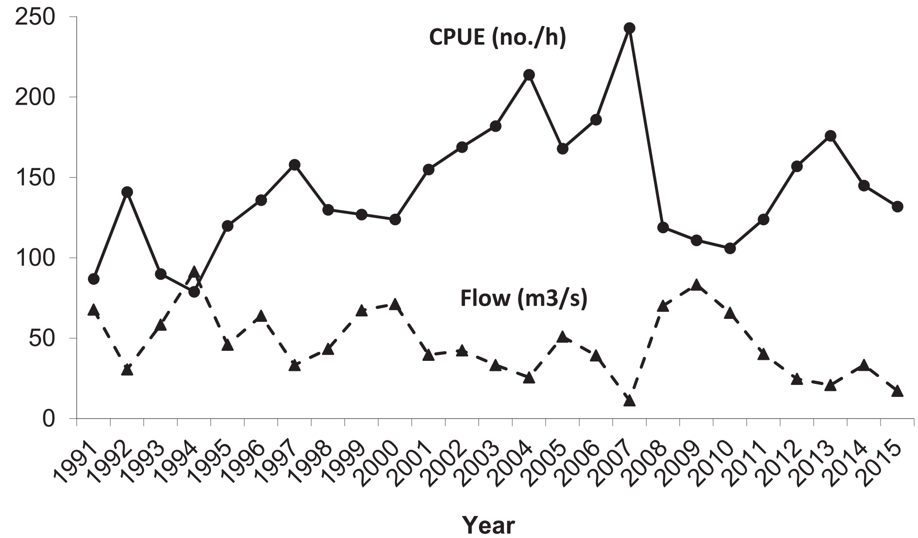

FIGURE 1. Largemouth Bass CPUE versus previous year's mean flow (m^3/s) in Lake Dardanelle (Pool 10) of the Arkansas River. Original data through 2009 are reprinted from Limbird and Leone (2009), with permission from the Arkansas Game and Fish Commission (AGFC). Additional data collected after 2009 are shown for comparison (AGFC, unpublished data). Flow values were divided by 25 for graph scaling purposes; both flow (m^3/s) and CPUE (fish/h) are plotted from the *y*-axis.

water retention times in all pools. The present-day MKARNS is designed to provide commercial navigation, hydroelectric power production, flood control, water supply, fish and wildlife habitat, environmental enhancement, and river channel stabilization for the lower Arkansas River valley.

Fish collections.— Largemouth Bass ($n = 2{,}155$; TL range = 112–596 mm; ages 1–10) and Spotted Bass ($n = 833$; TL range = 96–427 mm; ages 1–8) were collected by standard boat-mounted electrofishing in accordance with the methods of Eggleton et al. (2011, 2013). Electrofishing was conducted during nighttime using a Smith-Root Model 7.5 GPP and standard Smith-Root electrofishing equipment (Briggs and Stratton 16-hp AC generator, booms, wiring, and dropper arrays; Eggleton et al. 2011, 2013). Electrofishing settings were standardized based on water temperature and conductivity of each river location to achieve an approximate power output of 3,000–3,500 W in all pools following Burkhardt and Gutreuter (1995).

All fish collections were made as part of companion research conducted during late spring/early summer in 2004, 2005, and 2010. The sampling program consisted of replicate 10-min electrofishing samples taken from each of 11 navigation pools. During 2004–2005 sampling, 12 electrofishing transects on average were completed for all 11 navigation pools, with more samples taken in larger pools. During 2010, a reduced sampling program was employed whereby 12 samples on average were taken each in Pools 2, 4, 6, and 10 only (Peacock 2011). Sample sites in each pool were selected under a stratified random scheme (Zar 1999), with main-channel border (e.g., bank revetments, dikes, sandbars, etc.) and off-channel (e.g., backwaters, floodplain lakes, side channels, etc.) macrohabitats representing the strata (Peacock 2011). For any given pool, N river miles (1 river mile = 1.609 river kilometers) contained within that pool were randomly selected for sampling (i.e., population elements or n). Due to the limited number of samples taken per pool, equal sampling effort was devoted to main-channel and off-channel macrohabitats. The first n randomly selected river miles to have sufficient off-channel habitats were sampled as off-channel sites, with the remaining n randomly selected river miles sampled as main-channel sites. Occasional ad hoc site substitutions were undertaken when warranted (e.g., if a site was inaccessible due to low stages or an unexpected habitat feature). This sampling scheme reduced the probability of highly biased estimates resulting from small sample sizes selected within a simple random design for a given pool. All black basses collected during sampling were returned on ice to the laboratory. In the laboratory, all fish were frozen for later processing, which occurred within 1–2 months of sampling.

Fish aging and growth increment determination procedures.— In the laboratory, individual black bass were thawed, measured (TL, mm), and weighed (g). Sagittal otoliths were extracted for age estimation, digitally imaged, and processed following the procedures described by Fernando et al. (2014). Black bass with an age of at least 3 years based on whole-view readings were transverse sectioned, digitally imaged, and re-aged following Buckmeier and Howells (2003). In all cases, ages determined from the sectioned otoliths were considered to be the "true" age of the fish and used in further analysis, regardless of whether they agreed with the whole-view readings. All otoliths were read double-blind by two independent readers; verification and reliability of the aging procedures used in this study were considered acceptable (Fernando et al. 2014).

From the digitized whole-view or sectioned otolith images, black bass ages were determined by counting individual annuli, with TL at age and annual growth increments derived using the direct proportion (Dahl–Lea) method. All growth increment measurements taken from otolith images were obtained using spatial analysis tools in Image Pro Plus version 4.5 (Media Cybernetics, Silver Spring, Maryland) or ImageTool version 2.0 (University of Texas Health Science Center, San Antonio). Once all ages were finalized, a von Bertalanffy growth curve (Isely and Grabowski 2007) was fitted for each species (with all pools combined) using nonlinear least-squares regression procedures in the Statistical Analysis System version 9.2 (SAS Institute, Cary, North Carolina). The model also was rearranged algebraically to predict the age of an individual for a specified TL.

Hydrologic classification of years.— Hydrologic data for the Arkansas River were obtained from the U.S. Army Corps of Engineers (USACE), Little Rock District, Little Rock, Arkansas (USACE 2011). Daily stage and flow data (m^3/s) for all 11 dams on the Arkansas River within Arkansas (Dams 2–13; there is no Dam 11) were used for analysis. The first dam (Dam 6) began operation in 1968, with other dams completed throughout 1968–1970. The Arkansas River navigation system became completely operational in June 1970 with the final completion of Dam 10 (Lake Dardanelle). There were only a few gaps in the data set, with almost a year of missing data from Dam 10 due to a broken gauge in 1980. In the end, a 42-year data set of mean daily flow spanning from 1969 through 2010 was assembled that characterized the Arkansas River's long-term hydrological conditions.

Using the compiled flow data set, individual years were categorized into groups representing the magnitude of their warm-season (April–September) flows. These groups were termed "high," "average," or "low" based on the quartiles of their mean April–September flows for the 1969–2010 time period. Using these classification criteria, years with mean April–September flows exceeding the 75% quartile (~2,124 m^3/s) were classified as "high flow," whereas years with mean April–September flows less than the 25% quartile (~991 m^3/s) were classified as "low flow." All remaining years in which mean April–September flows fell between these quartiles were classified as "average flow." This approach, applied to 42 years of data, was used to classify the 13 years during the 1998–2010 period, which corresponded to the growth years actually experienced by the Arkansas River black bass populations sampled during 2004, 2005, and 2010.

Data analysis.— Our analysis combined all 3 years of black bass growth increment data and encompassed the 13 years of hydrology from 1998 through 2010. Given that 99% of all black bass examined during 2004–2005 and 2010 were age 6 or younger ($n = 2{,}956$), focus was placed on these fish by using only back-calculated ages 1–6 to compute growth increments. This also kept the statistical design more balanced given that the abundance of age-7 and older black bass was extremely low ($n = 32$), equating to about 1% of the total sample. Growth increment data were assembled into a two-way factorial ANOVA, with age ($k = 6$; i.e., back-calculated ages 1–6) and flow ($k = 3$; i.e., year classifications as described above) serving as the main effects, and an additional term was included that reflected the age × flow interaction (Isely and Grabowski 2007). This analysis was conducted separately for each black bass species. Mean annual growth increment of individual black bass was the response variable, with growth increments generated from individual bass serving as the replicates. For cases in which a significant age × flow interaction was detected, completely randomized one-way ANOVAs and Duncan's multiple-range post hoc tests were run separately for each age in order to decompose the statistical interaction detected from the two-way ANOVA. All statistical analyses were conducted using the Statistical Analysis System version 9.2. For all analyses herein, statistical significance was declared at an α level of 0.05.

RESULTS

Hydrologic Analysis

Hydrology in the Arkansas River has been variable through time since complete closure of the MKARNS in 1970. In terms of flow magnitude during the 42-year timeframe, mean annual flow varied more than fivefold from 482 m^3/s in 1980 to 2,707 m^3/s in 1973; average annual flow during this same period was 1,320 ± 534 m^3/s (mean ± SD; Figure 2). During 1998–2010 in the Arkansas River, 34% (range = 10–64%) of the days per year on average had flows below 425 m^3/s (Table 1). For the high-flow metrics that occurred during the same time period, 33% (range = 11–53%) of the days on average had flows greater than 1,415 m^3/s (Table 1). However, that figure steadily decreased as the flow criterion was increased to greater than 2,123 m^3/s (21%) or greater than 2,831 m^3/s (14%). By comparison, only 5% (range = 0–15%) of the days per year on average had flows greater than 4,247 m^3/s (Table 1). In general, the upper and lower ends of these ranges were consistent with the categorical flow classifications discussed previously. During three consecutive years in particular (2007–2009), the lower Arkansas River experienced long durations of high flows. Mean annual flows during these years exceeded the 42-year average by 52%, with 29% of the days during these years exceeding a flow of 2,831 m^3/s. Summer (June–August) flows alone during these years averaged 107% above normal.

During 1969–2010, April–September flows were slightly greater (mean = 1,400 m^3/s) and more variable (SD = 725 m^3/s) than annual estimates (Figure 2). In examining only April–September flows recorded from 1998 to 2010, we found that 2008 had the greatest mean flow (3,204 m^3/s), whereas 2006 had the lowest mean flow (372 m^3/s; Figure 2), which was about one-ninth that in 2008. The quartile approach employed on these data classified 4 years as low flow (1998, 2001, 2003, and 2006), 4 years as high flow (1999, 2004, 2007, and 2008), and 5 years as average flow (2000, 2002, 2005, 2009, and 2010). Additionally, in terms of mean, minimum, maximum, and quartile flows, this 13-year period of record appeared representative of the larger 42-year data set. Although mean April–September flows during 1998–2010 were about 8% greater compared to flows in 1969–2010, the 25% quartile flows were nearly identical between the two groups. The 75% quartile for 1998–2010 was about 500 m^3/s greater than that of the 42-year data set owing to the shorter duration of the data set and substantially greater flows observed during 2007–2008, both of which were over 2 SDs greater than the mean. In any event, we considered our categorical characterization of long-term hydrology in the Arkansas River as reasonable and defensible for our purposes.

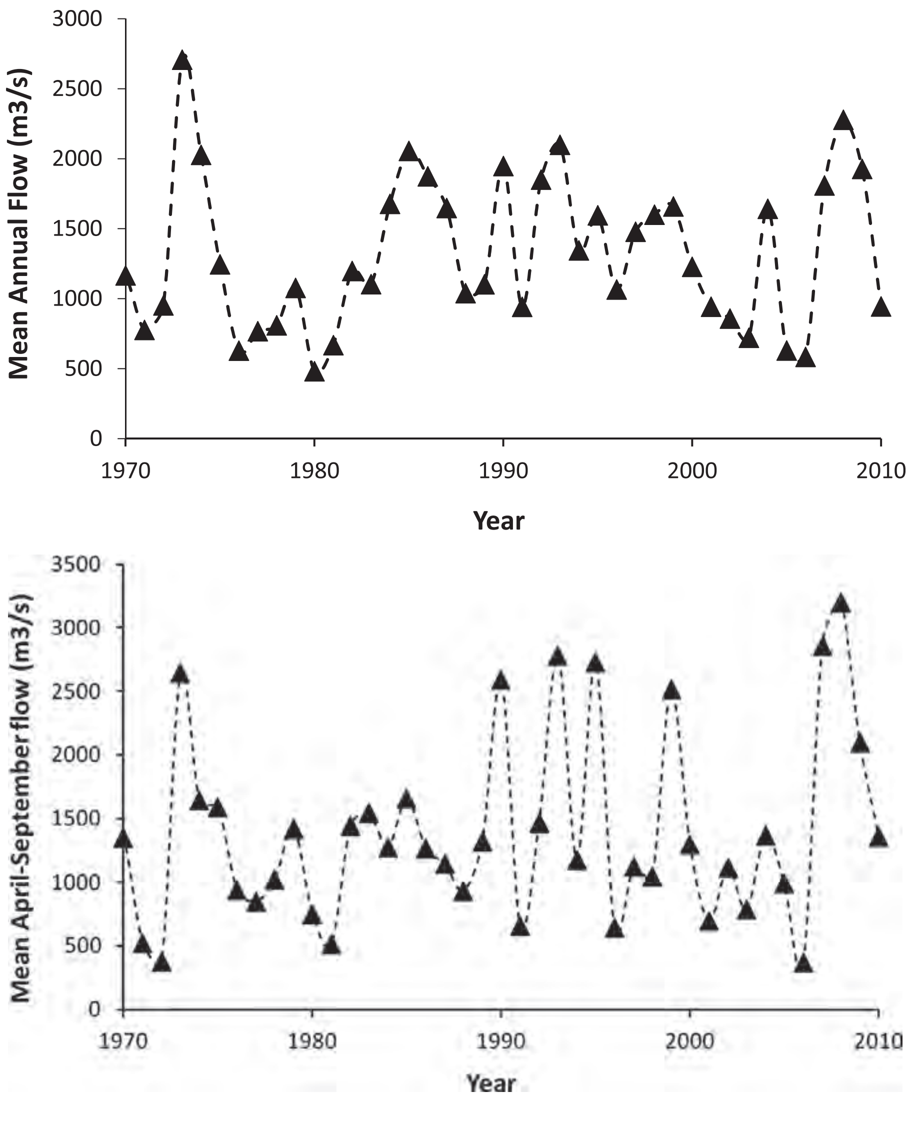

FIGURE 2. Mean annual (March–February) flow for the Arkansas River by growth year since impoundment (1970–2010; top panel) and mean April–September flow for the Arkansas River (1970–2010; bottom panel). Each data point represents the mean daily flow averaged across all 11 dam tailwaters for the period represented in each panel.

TABLE 1. Proportion of days with tailwater flows below 425 m^3/s (≤425 m^3/s) or above the specified levels by growth year. A growth year is defined as extending from March 1 through the last day of February in the following year. Values were from means generated across all dam tailwaters in the Arkansas River within Arkansas.

	Tailwater flow (m^3/s)				
Growth year	≤425	≥1,145	≥2,123	≥2,831	≥4,247
1998	0.25	0.44	0.31	0.21	0.03
1999	0.37	0.41	0.36	0.28	0.12
2000	0.31	0.33	0.18	0.10	0.02
2001	0.47	0.20	0.11	0.08	0.04
2002	0.48	0.20	0.09	0.04	0.01
2003	0.41	0.11	0.02	0.01	0.00
2004	0.21	0.48	0.27	0.17	0.05
2005	0.52	0.13	0.05	0.01	0.00
2006	0.64	0.12	0.05	0.02	0.01
2007	0.19	0.45	0.31	0.22	0.10
2008	0.13	0.53	0.42	0.36	0.15
2009	0.10	0.52	0.33	0.21	0.09
Average	0.34	0.33	0.21	0.14	0.05

Black Bass Populations

Age frequencies of both black bass populations exhibited some variation across the three sampling years. Typically, the age-1–3 cohorts dominated the populations, comprising 83% ($n = 2{,}487$) of the total sample (Table 2). Variation across years with these percentages was assumed to represent recruitment variation and differential year-class strengths. All age-4 and older cohorts comprised a smaller percentage of the total sample, collectively constituting about 17% of the overall sample (Table 2).

Across the 3 years of sampling, back-calculated lengths at age of Largemouth Bass averaged (±SE) 179 ± 6 mm at age 1; 270 ± 7 mm at age 2; 327 ± 9 mm at age 3; 364 ± 8 mm at age 4; 386 ± 6 mm at age 5; 389 ± 7 mm at age 6; 407 ± 15 mm at age 7; 425 ± 15 mm at age 8; 434 ± 178 mm at age 9; and 437 mm at age 10 (Table 3). Furthermore, mean back-calculated lengths at age generally declined in 2010 for age-1–4 cohorts (Table 3). The von Bertalanffy growth model parameters for Largemouth Bass in 2004 were 412 mm for asymptotic length (L_∞), 0.499 for the growth coefficient (K), and −0.270 for theoretical age at zero length (t_0). For 2005, growth model parameters were 451 mm for L_∞, 0.397 for K, and −0.283 for t_0. Growth model parameters for 2010 were 476 mm for L_∞, 0.289 for K, and −0.581 for t_0.

Across the same years of sampling, back-calculated lengths of Spotted Bass at ages 1–8 averaged (±SE) 149 ± 2 mm at age 1; 234 ± 2 mm at age 2; 283 ± 6 mm at age 3; 313 ± 9 mm at age 4; 338 ± 12 mm at age 5; 349 ± 15 mm at age 6; 366 ± 150 mm at age 7; and 381 mm at age 8 (Table 3). Similar to Largemouth Bass, mean back-calculated lengths at age generally declined in 2010 for several Spotted Bass cohorts (Table 3). The von Bertalanffy growth model parameters for 2004 were 400 mm for L_∞, 0.387 for K, and −0.231 for t_0. For 2005, growth model parameters were 396 mm for L_∞, 0.434 for K, and −0.048 for t_0. For 2010, growth model parameters were 350 mm for L_∞, 0.446 for K, and −0.312 for t_0.

Growth–Hydrology Relationships

For Largemouth Bass, two-way factorial ANOVA results indicated that the effect of age ($F = 2{,}026.8$, df = 5, $P < 0.0001$) was significant with respect to growth increment, meaning that growth increment varied across ages. Although the flow effect was not significant by itself ($F = 1.34$, df = 2, $P = 0.2632$), flow did significantly interact with age ($F = 6.53$, df = 9, $P < 0.0001$), suggesting that flow affected Largemouth Bass growth differentially across ages. Given the significant age × flow interaction, completely randomized one-way ANOVAs and Duncan's multiple-range post hoc tests were run separately for ages 1–6 to decompose the statistical interaction. From these analyses, the age-1 cohort (i.e., growth increment from age 0 to age 1 or first-year growth) and age-2 cohort (i.e., growth increment from age 1 to age 2) exhibited significantly greater growth during years of low-flow and average-flow conditions than during years of high-flow conditions in the Arkansas River ($P < 0.0001$; Figure 3). Growth of both cohorts also was greater during low-flow years compared to average-flow years ($P < 0.0001$; Figure 3). The age-3 cohort (i.e., growth increment from age 2 to age 3) exhibited variation across flow categories, although the effect was different than that for ages 1 and 2. With this cohort, low-flow and average-flow years were the only flow categories that significantly differed in growth ($P < 0.0001$). Conversely, the age-4 and age-5 cohorts (i.e., growth increments from age 3 to 4 and from age 4 to 5) exhibited greater growth during high-flow years than during low-flow or average-flow years ($P = 0.0008$–0.0421; Figure 3). In general, greater flows appeared to have enhanced the annual growth increment of older, and hence larger, Largemouth Bass in the Arkansas River. However, that same hydrologic characteristic may have been detrimental to younger, smaller Largemouth Bass. The effect was most pronounced for the age-1 and age-2 cohorts, which on average constituted the largest segment (60–70%) of the population.

For Spotted Bass, two-way factorial ANOVA results indicated that the effects of age ($F = 1{,}109.9$, df = 5, $P < 0.0001$) and flow ($F = 5.47$, df = 2, $P = 0.0043$) were significant with respect to growth increment. Furthermore, the age × flow interaction was significant ($F = 1.72$, df = 10, $P = 0.0499$), which suggested that flow also affected Spotted Bass growth differently across ages. Because the age ×

TABLE 2. Age frequency for Largemouth Bass ($n = 2,155$) and Spotted Bass ($n = 833$) that were collected from the Arkansas River and used in this study. Ages from age-3 and older black bass were based on sectioned otoliths. Numbers in parentheses represent the percent contribution to the entire sample. Nine Largemouth Bass were discarded because their otoliths could not be aged.

	Largemouth Bass			Spotted Bass		
Age	2004	2005	2010	2004	2005	2010
1	395 (42)	166 (21)	144 (35)	105 (29)	133 (36)	41 (43)
2	307 (32)	323 (41)	90 (22)	121 (33)	134 (36)	27 (28)
3	142 (15)	157 (20)	44 (11)	104 (28)	49 (13)	5 (5)
4	57 (6)	92 (12)	89 (22)	8 (2)	42 (11)	8 (8)
5	33 (3)	27 (3)	28 (7)	19 (5)	5 (1)	9 (9)
6	7 (1)	19 (2)	10 (2)	2 (1)	10 (3)	3 (3)
7	5 (1)	6 (1)	1 (<1)	5 (1)	0 (0)	2 (2)
8	2 (<1)	2 (<1)	2 (<1)	1 (<1)	0 (0)	0 (0)
9	1 (<1)	2 (<1)	0 (0)	0 (0)	0 (0)	0 (0)
10	2 (<1)	2 (<1)	0 (0)	0 (0)	0 (0)	0 (0)
Total	951	796	408	365	373	95

TABLE 3. Mean back-calculated length at age (mm TL; SE in parentheses) of Largemouth Bass and Spotted Bass collected from the Arkansas River in 2004, 2005, and 2010.

	Largemouth Bass			Spotted Bass		
Age	2004	2005	2010	2004	2005	2010
1	190 (1)	177 (1)	170 (2)	149 (1)	145 (1)	152 (4)
2	282 (2)	270 (2)	258 (2)	237 (2)	233 (2)	231 (6)
3	337 (3)	335 (2)	308 (3)	289 (3)	290 (3)	271 (9)
4	371 (4)	372 (4)	349 (3)	318 (5)	326 (4)	295 (10)
5	384 (7)	397 (7)	378 (4)	340 (5)	358 (8)	315 (11)
6	376 (10)	398 (9)	394 (12)	364 (7)	364 (9)	319 (8)
7	380 (13)	412 (10)	430 (17)	385 (7)		347 (19)
8	395 (16)	440 (8)	439 (57)	381		
9	415 (19)	453 (4)				
10	437 (18)					

flow interaction was significant, we conducted completely randomized one-way ANOVAs and Duncan's multiple-range post hoc tests for ages 1–6 to decompose the statistical interaction. Similar to Largemouth Bass, the age-1–3 cohorts (i.e., growth increments from age 0 to 1, from age 1 to 2, and from age 2 to 3, respectively) of Spotted Bass all exhibited significantly greater growth increments during low-flow and average-flow years compared to high-flow years ($P < 0.0001$; Figure 3). Like the results for Largemouth Bass, greater flows appeared to have inhibited the annual growth increments of younger, smaller Spotted Bass in the Arkansas River, with the age-1–3 cohorts showing a particularly consistent response. However, unlike Largemouth Bass, growth increments for Spotted Bass were similar regardless of flow levels for all older, larger cohorts (ages 4–6; i.e., growth increments from age 3 to 4, from age 4 to 5, and from age 5 to 6, respectively; $P = 0.1160$–0.8265; Figure 3). Overall, the trend for Spotted Bass was similar to that observed with Largemouth Bass and suggested that the growth of younger, smaller black bass may be negatively affected by excessively high flows and flooding compared with the growth of older, larger individuals.

DISCUSSION

The possible linkage between Largemouth Bass and flows in the Arkansas River had been hypothesized previously by Arkansas Game and Fish Commission biologists working on Lake Dardanelle (Pool 10) in western

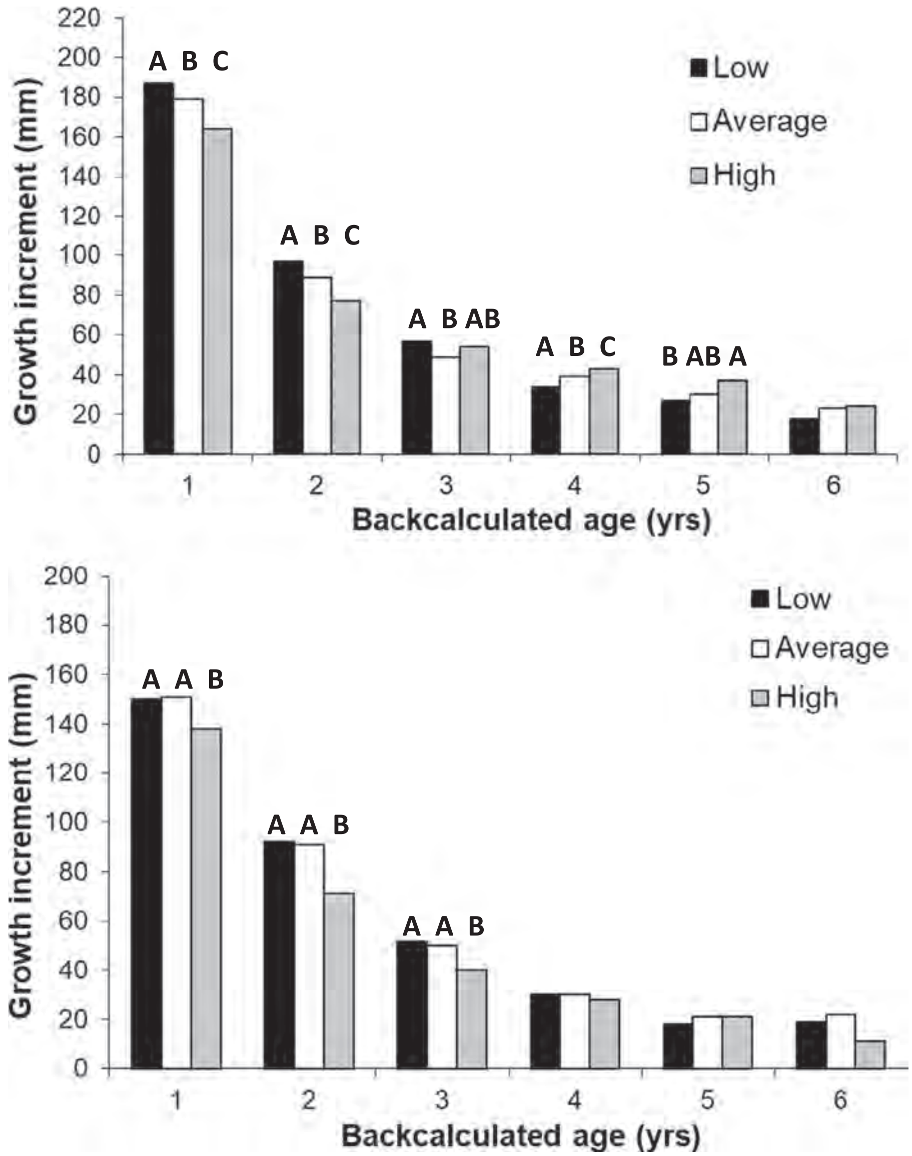

FIGURE 3. Mean annual growth increment for Largemouth Bass (top panel) and Spotted Bass (bottom panel) by age under the various Arkansas River flow classifications (low, average, and high; defined in text). Back-calculated ages 1–6 (years; *x*-axis) correspond to annual growth increments (*y*-axis) as follows: age 1 corresponds to the growth increment from age 0 to age 1; age 2 corresponds to the growth increment from age 1 to age 2; and so on. Within a given age, bars with the same letters indicate that values were not significantly different. When no letters are shown, no means were significantly different.

Arkansas (Limbird and Leone 2009). Their data set, which was assembled over more than two decades, illustrated a distinctly inverse relationship between Largemouth Bass CPUE and the previous year's mean flow (Figure 1). Although they did not examine the growth of Largemouth Bass or Spotted Bass, their results strongly suggested a probable link between Largemouth Bass recruitment and flow in at least one area of the Arkansas River. We did not thoroughly assess recruitment in the present study, but the data collected supported a possible linkage between black bass growth and hydrology in the Arknsas River. In general, observations suggested that years with greater flows translated into decreased annual growth for two common black bass species, with the decrease being most evident among the younger and smaller cohorts. This phenomenon was reported from a similar study on Largemouth Bass in the nearby Ouachita River, which suggested inverse relationships between growth increment and flow levels, with the effect being most pronounced for ages 2–4 (Hecke et al. 2016).

We did consider other hypotheses besides river hydrology that might have explained our findings. Regarding the possibility that black bass growth and recruitment were exhibiting a simple density-dependent relationship, evidence was lacking for both populations. Under this scenario, inverse relationships between the growth of younger black bass cohorts and flows may have been related to recruitment variation for one or both species. Had this phenomenon been occurring, younger cohorts would have exhibited large negative catch-curve residuals (i.e., weak year-classes) coinciding with years of better growth and large positive catch-curve residuals (i.e., stronger year-classes) during years of lower growth. This pattern was not apparent for either black bass species (Figure 4). Thus, growth and recruitment of Largemouth Bass and Spotted Bass did not appear to strongly interact in a density-dependent fashion in the Arkansas River. Although this phenomenon has been reported in other studies and in reviews (e.g., Lorenzen and Enberg 2001; Maceina 2004), the degree to which it might have been occurring in the Arkansas River may have been difficult to detect given the large size of the system.

The idea that high flows may negatively affect black bass growth has been suggested but not widely researched or documented. In this study, both annual and April–September flows were very different in the Arkansas River during the years preceding the black bass assessments (i.e., during 2001–2003 [prior to the 2004–2005 assessments] and during 2007–2009 [prior to the 2010 assessment]; Figure 2). Under the classification scheme outlined above for April–September flows, the Arkansas River experienced three low-flow years (1998, 2001, and 2003) and two average-flow years (2000 and 2002) prior to the 2004–2005 assessments. Conversely, the river experienced two high-flow years (2007–2008) and one average-flow year (2009) prior to the 2010 assessment (although 2009 was classified as high flow based on annual flows). In effect, Arkansas River black bass populations that existed during the 2004–2005 assessment had not experienced above-average or otherwise high-flow conditions for any extended period of time throughout their entire lives. Conversely, the populations that existed during the 2010 assessment had experienced consecutive years of above-average, high-flow conditions throughout the river. This time period encompassed the entire lives for much of the black bass populations sampled in 2010. In fact, the vast majority of both black bass populations sampled in 2010 had never experienced a low-flow year.

The supposition that flows may negatively affect black bass growth in the Arkansas River was corroborated by other data. First, mean back-calculated lengths at age were significantly ($P \leq 0.05$) smaller in 2010 compared to 2004–2005 for age-1–3 cohorts of Largemouth Bass, although Spotted Bass results were less clear due to a limited 2010 sample size ($n = 95$). Second, growth model results indicated that Largemouth Bass required an average of 4.9, 4.4, and 5.1 years to achieve 381 mm TL during 2004, 2005, and 2010, respectively. When 2004 and 2005 data were pooled, 4.6 years were required to attain 381 mm TL. Similar modeling indicated that Spotted Bass required an average of 3.5, 3.3, and 4.3 years to achieve 304 mm TL during 2004, 2005, and 2010, respectively. Thus, after consecutive years of high-flow conditions in the Arkansas River (2007–2008, with 2009 being borderline), Largemouth Bass required an additional 0.5 year on average to attain the legal minimum length for harvest at the time (381 mm TL). Similarly, Spotted Bass required an extra 0.9 year on average to reach 304 mm TL (common minimum length limit for the species). Thus, depressed growth for both black bass species appeared to be associated with sustained periods of high flows in the Arkansas River.

The growth–flow linkage proposed here for younger, smaller black bass is, of course, speculative and based only on association. However, if present it may have had a compounding effect on the populations such that a "growth deficit" was created for these cohorts—a deficit from which they might not have recovered. For instance, when the annual growth of a Largemouth Bass is hindered during the first 2–3 years of its life, the effect is compounded such that cohort mean size is reduced over several years. Recovery from this deficit may be difficult because cohort growth potential declines with age. In other words, above-average growth at age 4 or 5 is unlikely to compensate for poor growth at ages 1 and 2, when growth potential is greater. Additionally, the relatively brief life span of both black basses in the Arkansas River (about 10 and 8 years for Largemouth Bass and Spotted Bass, respectively) provides fewer years to compensate for this growth deficit. Although a 20–25-mm growth decline may seem quite small, the cumulative effect throughout the life of the cohort may become detectable in terms of the size structure of the fishery and would likely be noticeable by anglers. If occurring, this effect would be especially applicable for a population that had experienced growth depression during three successive years. In this case with Largemouth Bass, as the 2007 and 2008 cohorts reached harvestable size (381 mm TL) they would have been 5.1 years old on average, representing only about 7% of the fishery at that time. By comparison, Largemouth Bass in 2004–2005 reached harvestable size at only 4.6 years, comprising 17% of the population at the time. This decrease translates to a nearly 60% decline in the abundance of harvestable-size Largemouth Bass between 2004–2005 and 2010. The decline is most likely explained by the additional natural mortality and other forms of fishing-related mortality to which these fish were subjected while needing another half-year of growth in order to attain harvestable size and enter the legal fishery. Although there is less sport interest in Spotted Bass in the Arkansas River,

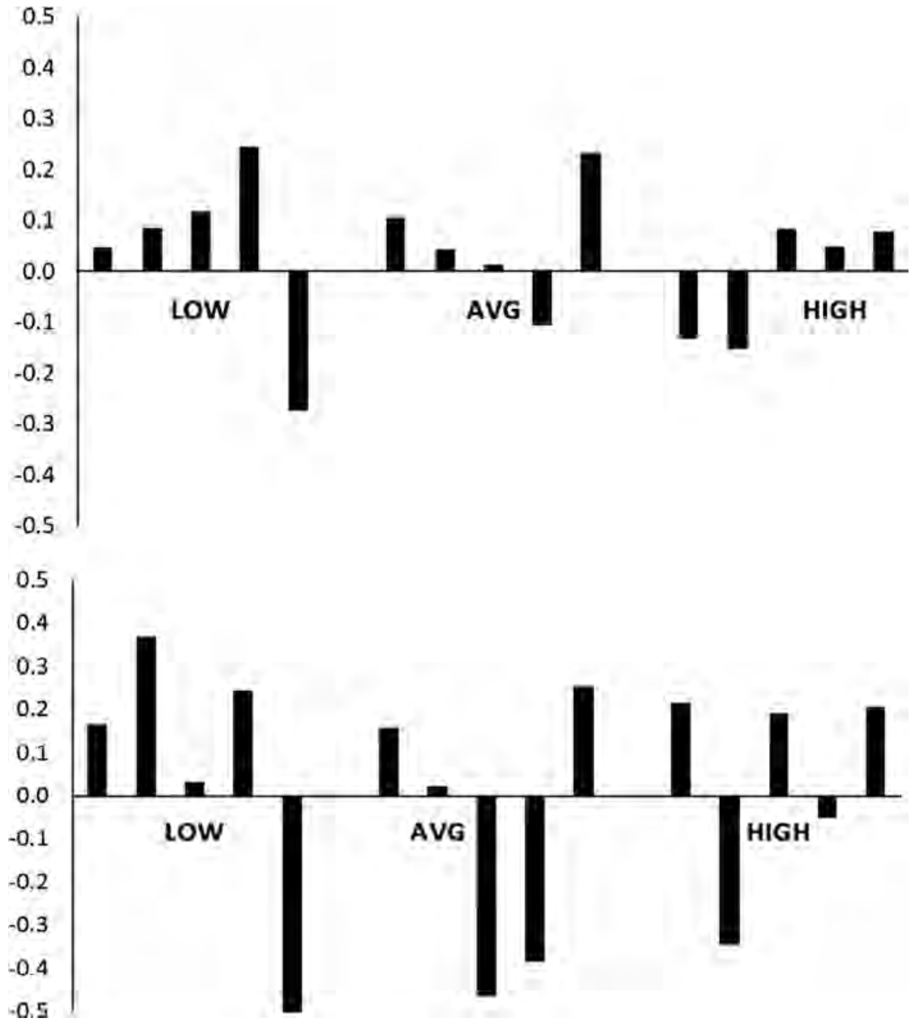

FIGURE 4. Catch-curve residuals for Largemouth Bass (top panel) and Spotted Bass (bottom panel) from the Arkansas River. For each graph, the *y*-axis plots the residuals from $\log_{10}$(catch)–age linear regression models by the flow categories defined in the text (low, average [avg], and high; *x*-axis). Each bar represents the ordinary residual of a single black bass cohort from one of the three sampling years (2004, 2005, and 2010). Bars are plotted in groups of five per flow category (irrespective of sampling years) and are ordered within each flow category by age (i.e., ages 2–6). Age-1 fish were excluded from catch curves due to suspected underrepresentation in samples.

similar conclusions would apply given that they needed an additional 0.9 year to attain 304 mm TL in 2010 compared to 2004–2005.

We do recognize that fish growth–flow relationships are complex and that other unmeasured factors could have influenced our findings, although to unknown extents. For example, Greene and Maceina (2000) reported that the dynamics (including growth) of age-0 Largemouth Bass and Spotted Bass were correlated to chlorophyll-*a*, water retention, water depth, and water level fluctuations in six Alabama reservoirs. Allen et al. (1999) reported that recruitment dynamics of Largemouth Bass in nine Alabama reservoirs were related to reservoir productivity levels (measured as chlorophyll-*a*) and larval shad *Dorosoma* spp. abundances. Using data from 15 Missouri reservoirs, modeling efforts by Siepker and Michaletz (2013) indicated links between Largemouth Bass and Spotted Bass recruitment and several environmental variables related to reservoir spring and summer water levels and air temperatures. Although these latter two studies did not emphasize growth to any large extent, the recruitment dynamics of Largemouth Bass are often highly interrelated with growth (Post et al. 1998). Unfortunately, there were no adequate environmental data sets from the Arkansas River available to complement our flow and black bass data sets. Data sets that were available were largely limited spatially or contained static variables that were fixed for each pool and did not vary with flow (e.g., Schramm et al. 2008). Thus, although warm-season hydrology was emphasized in this study, we acknowledge that flow could have interacted with other variables that were not measured or not available. On the other hand, although we would expect flow to be an important factor in a serial lock-and-dam system like the Arkansas River (e.g., Quinn and Limbird 2008), the above-average flows experienced in the latter portion of this study (2010) may have influenced black bass growth to a greater extent than they normally would.

Reductions in black bass growth coinciding with periods of high water in the Arkansas River would seem to run counter to the main tenets of the flood pulse concept (Junk et al. 1989). Seasonal high-flow conditions or "flood pulses" in large-river ecosystems are purported to have beneficial effects for most riverine fishes (Junk et al. 1989). These benefits emphasize access to adjacent floodplains and other off-channel habitats for feeding, spawning, and rearing of larvae and juveniles (Raibley et al. 1997; Greene and Maceina 2000). However, implicit within the flood pulse ideology is that a "true" river floodplain exists. Present-day levels of floodplain connectivity in the impounded reach of the Arkansas River (i.e., contained within the MKARNS) are low, with much of the historical floodplain isolated by a main-line levee system. Schramm et al. (2008) reported that floodplain and backwater habitats in the Arkansas River have been steadily decreasing since closure of the MKARNS nearly 50 years ago. From 1973 to 1999, navigation pools in the river have lost 9% of their aquatic habitat on average, with losses ranging from 1% in Pool 3 to 17% in Pool 12. In terms of floodplain and backwater habitats, all navigation pools except one have experienced long-term losses, ranging from 17% in Pool 13 to 39% in Pool 8 and averaging 15% (Schramm et al. 2008). Thus, extensive levee networks and the long-term losses of floodplain and backwater habitats could be limiting the growth and abundance of some Arkansas River fishes, but this may be more evident with species that evolved in river–floodplain environments (e.g., Largemouth Bass and Spotted Bass).

How might floodplain and backwater habitat losses and high flows interact to affect Arkansas River black bass? It is possible that black basses inhabiting the main channel or adjacent habitats (e.g., dike fields) are unable to find adequate refugia from the extreme high-flow conditions that periodically occur according to the long-term hydrograph. For instance, dike fields provide ample low-current habitats for fish, including black basses, but only during low-flow periods. However, as river stages increase and flows overtop dikes, the dike fields become relatively unstable, high-current habitats with high degrees of scouring, variable flow patterns, and high levels of sediment deposition (although additional scouring may occur during receding flows). Other low-current habitats are available during flooding (e.g., oxbow lakes still inside the levees), but these habitats are extremely limited in the present-day Arkansas River and are not available in all pools of the river (Schramm et al. 2008). Thus, the growth of certain Arkansas River fishes may respond negatively to long, protracted flooding events that occur without access to suitable floodplain habitats isolated by the present-day levee system. Furthermore, these effects may be more evident with younger (and often smaller) juvenile or subadult individuals (e.g., Miranda et al. 1984), which is consistent with the results of this study. It is also possible that impounded and heavily regulated river systems like the modern-day Arkansas River do in fact undergo an "aging" process, as has been widely documented in other types of reservoirs (Kimmel and Groeger 1986). The proposed inverse linkage between black bass growth and flow with respect to Largemouth Bass and Spotted Bass may be a symptom of that aging process and could be occurring in many similar impounded river systems. Although more research is needed, this possibility would be of great interest to fisheries managers and could assist with future black bass management in light of hydrologic variability being proposed from climate change processes and habitat changes related to reservoir aging.

ACKNOWLEDGMENTS

This research was funded by the Aquaculture/Fisheries Center at the University of Arkansas at Pine Bluff (UAPB). We thank the many UAPB students and staff that assisted with fish sampling, processing, and aging over the years. We appreciate the extensive Arkansas River hydrologic data set provided by the USACE–Little Rock District and their guidance with interpretation of the data set. We appreciate the two anonymous reviewers for their help in improving the manuscript. There is no conflict of interest declared in this article.

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J. N. Am. Benthol. Soc., 2001, 20(2):225–240

Importance of flood regime to invertebrate habitat in an unregulated river–floodplain ecosystem

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Abstract. Unlike most large rivers of the northern hemisphere, several medium-sized rivers in the southeastern USA Coastal Plain remain unregulated. These smaller rivers possess 2 habitat types (snags and floodplain) that were historically important for invertebrate assemblages in many rivers and are strongly dependent on flood regime. I reviewed and compared 2 models of habitat inundation (snags and floodplain) that were developed for the Ogeechee River (Georgia, USA) to understand the ecological significance of these habitats. These models showed that snag habitat surfaces varied from only ~20 to 50% of channel bottom surfaces, but floodplain inundation varied from 0 to 37 times the width of the channel at 100% inundation. Long-term analysis of inundation patterns from a 58-y record of discharge demonstrated that substantial flooding occurred almost annually for 1 to 2 mo/y. Habitat-specific invertebrate biomass was highest on snags (mostly aquatic insects), followed by the main channel (dominated by *Corbicula*), and then the floodplain (oligochaetes, crustaceans, aquatic insects). After correction for total amount of habitat surface area, invertebrate biomass contributions were highest in the floodplain > main channel > snag. However, arthropods and oligochaetes, the most likely prey of higher trophic levels, were clearly dominant on snags and in the floodplain. In many rivers around the world, invertebrate productivity from snags and floodplains is likely to have been significantly diminished because of snag removal, channelization, and floodplain drainage for >2 centuries. Understanding the interaction between flood regime and invertebrate habitat in unregulated rivers like the Ogeechee River can serve as a benchmark in restoration efforts.

Key words: floodplain, river swamp, flooding, invertebrate habitat, inundation, snags, wood, river management, Coastal Plain river, invertebrate biomass, flood pulse.

In recent years, ecologists have recognized that the phenomenon of a flooding river often represents a beneficial ecological connection between the river and its semiaquatic floodplain, rather than an unpredictable catastrophic disturbance (e.g., Junk et al. 1989). This mutual subsidy between river and floodplain has been recognized primarily in large rivers, particularly those in the tropics (i.e., the flood pulse concept; Junk et al. 1989). In contrast, much of the early theory of lotic ecology was developed for small streams and rarely considered the floodplain (but see Smock et al. 1992). Even the river continuum concept, which described trends in processes from headwaters to a large river, did not incorporate the floodplain influence (Vannote et al. 1980; but see Cummins et al. 1983 and Sedell et al. 1989). The difference in paradigms developed for large-river and small-stream ecology probably was exacerbated by human regulation of most large- and medium-sized rivers in the north-temperate zone (e.g., Benke 1990, Dynesius and Nilsson 1994). Much of this regulation occurred before the modern era of lotic ecology had begun (i.e., by the early 1970s).

Despite widespread regulation, however, medium-sized free-flowing rivers still exist in the USA, especially in the southeastern Coastal Plain (Benke 1990). Like the large rivers envisioned in the flood pulse concept, these Coastal Plain rivers are prone to extensive flooding at least annually. The study of such rivers not only can help us understand the ecological role of flooding in medium-sized rivers, and serve as a benchmark for restoration of damaged systems, but also may be useful in understanding large rivers. Furthermore, comparison of hydrological and ecological characteristics of southeastern USA rivers with other rivers throughout the world can help us understand the various ways that climate affects flooding (Benke et al. 2000).

My colleagues (see acknowledgements) and I conducted ecological studies of one of these medium-sized Coastal Plain rivers, the Ogeechee River, during the 1980s. The impetus for this

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study was prior research on a similar system, the Satilla River, which showed that snags (submerged woody substrate) were a center of invertebrate diversity and production (Benke et al. 1984, 1985, 1986). For many years, snags were viewed as obstructions to navigation by fishermen, recreational boaters, and commercial activities, and much of this wood was removed from southeastern rivers (Wallace and Benke 1984). The Ogeechee River study also focused on the importance of snag habitat, but in addition examined several functional aspects of the system, including the trophic basis of invertebrate production and river–floodplain interactions.

This paper represents a partial synthesis of research on the Ogeechee River, focusing on the relationship between discharge and habitat (snag and floodplain) inundation, and the influence of habitat availability on the abundance and biomass of invertebrate assemblages. General overviews of the Ogeechee River study may be found in Benke and Meyer (1988), Meyer (1990), and Meyer et al. (1997), and more detailed treatments of trophic pathways and C dynamics may be found in individual papers (e.g., Wallace et al. 1987, Meyer and Edwards 1990, Benke and Wallace 1997).

Ecosystem-level measurements of invertebrate abundance and biomass required quantification of the major habitats, and 2 models were developed for this purpose. One quantified the amount of snags inundated (Wallace and Benke 1984), and the other quantified the amount of floodplain inundated (Benke et al. 2000). Here, I compare the predictions of these models, and describe some long-term inundation patterns based on the floodplain model. Then I show how the models can be applied to quantifying the habitat-specific invertebrate assemblage using a combination of published and unpublished invertebrate data. Although production has been estimated for several invertebrate groups (e.g., Benke and Jacobi 1994, Benke and Wallace 1997, Benke 1998), only abundance values (density and biomass) of the major taxonomic groups are presented here.

Methods

Study site

The Ogeechee River is a low-gradient, 6th-order subtropical river in eastern Georgia, USA (lat ~32°N), flowing mostly through the Coastal Plain (Fig. 1, Table 1). The river channel meanders within a floodplain swamp forest for most of its length, averaging ~1.2 km in width (37 times the width of the channel) at the study site. Annual mean water temperature is almost 19°C, with winter values rarely falling below 10°C and summer values sometimes reaching 30°C. Although precipitation is relatively even throughout the year, high air temperatures in summer (daily mean >25°C vs annual mean = 17°C) greatly increase evapotranspiration (as high as 10 cm/mo), resulting in much lower runoff in summer than in winter (Benke et al. 2000).

FIG. 1. Location of Ogeechee River basin in the southeastern USA. AL = Alabama, GA = Georgia, SC = South Carolina, FL = Florida.

The main channel consists of an unstable sandy substrate, and snags from trees that have fallen into the river along its banks. The floodplain swamp consists of a mature 2nd-growth forest. The dominant trees are *Quercus laurifolia* (diamond leaf oak), *Liquidambar styraciflua* (sweetgum) and *Pinus glabra* (spruce pine) at the higher elevations of the floodplain, and *Taxodium distichum* (bald cypress), *Nyssa sylvatica* var. *biflora* (swamp blackgum), and *Acer rubrum* (red maple) at the lower elevations (Pulliam 1993). The edge of the river swamp is well defined by an upland area commonly converted to agriculture and pine forest. Organic matter fluxes from the floodplain to the river greatly

TABLE 1. Physical, chemical, and organic matter characteristics for the Ogeechee River. Mean annual precipitation and mean annual air temperature were calculated from the University of Georgia State Climate Office website (http://climate.engr.uga.edu/) for Millen, Georgia. Mean annual discharge and mean annual runoff were calculated from the US Geological Survey website (http://waterdata.usgs.gov/nwis-w/GA/) for Eden, Georgia.

Variable	Value	Source of data
Physical characteristics		
Gradient (cm/km)	20.0	
Mean annual air temperature (°C)	17.1	UGA State Climate Office
Mean annual water temperature (°C)	18.5	Benke and Meyer 1988
Mean annual discharge (m^3/s)	67.0	US Geological Survey
Mean annual runoff (cm)	31.2	US Geological Survey
Mean annual precipitation (cm)	109.6	UGA State Climate Office
River channel width (m)	33.0	
Floodplain width (km)	1.2	
Chemical characteristics		
pH	6.5	Meyer 1992
Alkalinity (mg $CaCO_3$/L)	23.0	Meyer 1992
N (mg NO_3-N/L)	0.10	Meyer 1992
P (mg PO_4-P/L)	0.05	Meyer 1992
Organic matter fluxes (g $m^{-2}y^{-1}$)		
Gross primary production (in river)	509.0	Edwards and Meyer 1987
Community respiration (in river)	2919.0	Edwards and Meyer 1987
Litterfall (in floodplain)	843.0	Cuffney 1988
Litter transport (to river)	3520.0	Cuffney 1988

exceed primary production within the channel (Table 1).

Quantification of habitats

River channel (benthic).—There was relatively little benthic habitat that ever became desiccated within the main river channel for all but the lowest discharge levels. Therefore, no attempt was made to model the amount of benthic habitat inundated because it was inundated most of the time.

River channel (snag).—Development of a snag habitat model for the main channel began with the quantification of wood surface area using a line–intersect technique during a low-discharge period (Wallace and Benke 1984). Stem diameters were measured in situ at 3 river heights: below the water surface, 0 to 1 m above the water surface, and 1 to 2 m above the water surface. The 2-m elevation approximated the height of the riverbank. From these data, Wallace and Benke (1984) developed the following predictive equation for estimating submerged snag surface area for a given river height or stage (at the nearest US Geological Survey [USGS] gaging station, at Eden, Georgia):

$$S_b = 0.368\ H^{0.280}\ (r^2 = 0.33,\ n = 63) \quad [1]$$

where S_b = wood surface area (m^2/m^2 of river bed), and H = height (m). River height during flooding rarely exceeded 1 m above the river bank, and extrapolation of the equation to 1 m above bank height only increased the wood surface area estimate by ~10%. This modest extrapolation seemed reasonable because wood above this height along the channel margin noticeably declines. This snag habitat model applied only to wood found within the river banks, and not to wood in the floodplain.

Floodplain.—A model was developed to quantify benthic habitat on the flooded portion of the Ogeechee River floodplain through time (Benke et al. 2000). Aerial photography was used to characterize inundation at different flood stages. The following model predicted % floodplain inundated as a function of river discharge at the USGS gaging station:

$$I = 0.345D + 1.358 \quad (n = 6,\ r^2 = 0.98,\ \text{range of } D = 17\text{–}255\ m^3/s) \quad [2]$$

where I = arcsine (% inundation), and D = discharge (m^3/s).

Long-term patterns of inundation were obtained by downloading 58 y of daily discharge data at the Eden gaging station from the USGS website (http://waterdata.usgs.gov/nwis-w/GA/) and converting discharge to % inundation using the above regression equation (Benke et al. 2000). Furthermore, an inundation-duration curve was developed from these data in which, for example, 50% inundation was predicted to occur for 15% of a year (i.e., 54 d/y). In this paper, I summarize the long-term pattern of inundation by plotting the number of days per year for which at least 50% of the floodplain was inundated each year.

Cuffney and Wallace (1987) earlier developed a floodplain model of the Ogeechee River based on ground-level measurements along a narrow transect. Pulliam (1993) later modified the model and recognized that it was not accurate for <2.2 m stage because local rainfall and groundwater inputs created greater inundation than predicted from the model; i.e., inundation was not created by river flooding. Although the new model (equation 2) was based on a much longer expanse of river-floodplain (6 km), it is subject to the same limitation for <2.2 m stage, which represents a predicted floodplain inundation of 25%.

Wood surfaces also were quantified on the floodplain using the line–intersect method (Benke and Wallace 1990). Mean surface area of woody debris on the floodplain bottom was <½ of that measured in the main channel. Unlike most channel wood, however, floodplain wood was dry for much of the year, was not anchored to the bottom, and often floated during floodplain inundation. Inspection of this unstable wood during flooding indicated few aquatic invertebrates, and thus they were not sampled. Tree trunk surfaces in the floodplain were measured at the same time as woody debris, and they were sampled for invertebrates because they appeared to be a much more stable and thus attractive habitat than loose woody debris. However, surface area of inundated tree trunks was <1% that of the inundated floodplain bottom throughout most of the year (A. Benke, unpublished data), and inundated tree trunks were not considered in this paper.

Invertebrate sampling

Invertebrates were sampled quantitatively from the benthic and snag habitats of the main channel, and the benthic habitat of the floodplain. Because of the intensive nature of the sampling procedures, it was not possible to sample the floodplain in the same year as the main channel. Sampling procedures and detailed taxon-specific biomass and production analyses for most of the main channel sampling have been published (see references below). Sampling procedures and invertebrate analyses for the floodplain have not been published and are presented below. Biomass values from all habitats were expressed as dry mass, usually estimated from length-mass regressions (Benke et al. 1999). Both habitat-specific and habitat-adjusted (per m^2 of channel bed) estimates of density and biomass were presented for the major taxonomic groups to compare the 3 habitats (channel bottom, snags, and floodplain) across the entire river section. I also included a brief summary of invertebrate drift analysis (Benke et al. 1991) because invertebrates in the water column may either grow in situ (zooplankton) as occurs in large rivers (e.g., Thorp et al. 1994) or may be dominated by benthic invertebrates as occurs in small streams (e.g., Waters 1972, Brittain and Eikeland 1988). Assessment of drift composition in rivers can provide independent evidence of the importance of particular invertebrate habitats (e.g., Benke et al. 1986) and river–floodplain connections. Also, the relative abundance of drifting macroinvertebrates and zooplankton may illustrate a transition from small-stream to large-river ecology.

River channel.—Invertebrates were sampled from the benthic habitat of the sandy main channel and adjoining backwaters, and from the snag habitat of the main channel at least monthly in 1982. Taxon-specific estimates of density, biomass, and production have been published for all invertebrate groups from the benthic habitat (Stites 1986, 1987, Stites et al. 1995). Only summaries of density and biomass for major taxonomic groups are presented here.

Taxon-specific estimates of density, biomass, and production have been published for all major invertebrate groups on the snag habitat, including black flies (Benke and Parsons 1990), mayflies (Benke and Jacobi 1994), caddisflies (Benke and Wallace 1997), chironomid midges (Benke 1998), and large invertebrate predators (Benke et al. 2001). Only summaries of density and biomass for these major groups, as well as unpublished data for the minor snag taxa (Oligochaeta, minor Diptera, Coleoptera, and Isopoda) are presented here. The snag inundation model was used to convert habitat-specific values to river bed values (equation 1).

Floodplain.—Invertebrate sampling of the Ogeechee River floodplain was conducted in 1986, a year similar to 1982 in that annual discharge was below the long- term average. I attempted to collect 3 monthly samples with a petite Ponar grab (244 cm^2) at each of 10 floodplain sites (Cuffney and Wallace 1987), although the actual number of samples per date depended on how many sites were wet, ranging from 3 (only 1 site wet) to 30 (all sites wet). Samples were rinsed through 1 mm and 100 μm sieves, similar to channel studies (e.g., Benke and Jacobi 1994, Stites et al. 1995).

Unfortunately, the floodplain inundation model (equation 2) could not be used for converting habitat-specific estimates of invertebrate biomass to the common unit of river bed because 1986 was a very dry year. All benthic samples were taken when river height was <2.2 m, a stage below which the model underestimated floodplain inundation. Therefore, inundation was estimated from field observations using Cuffney and Wallace's (1987) original inundation markers, as the fraction of each site inundated at the time of invertebrate sampling ($\times$ 25%, the model's estimate for inundation at 2.2 m height). Habitat-specific biomass was multiplied by a date-specific conversion (% inundation $\times$ 37) to estimate biomass per m^2 of river bed.

Drift.—Monthly drift samples were collected after dusk from the main channel during 1982 and 1983 (Benke et al. 1991). Drift density and biomass of the major invertebrates from 1982 are presented here to illustrate their relationship with habitat-specific values from the same year.

Results

Habitat dynamics

Mean daily discharge, submerged snag surface area, and floodplain inundation are illustrated for 1982, the year in which invertebrates were sampled from the main channel (Fig. 2). Data are also shown for 1983 to illustrate differences between below-average (52 m^3/s in 1982) and above-average discharge years (83 m^3/s in 1983). The inundation pattern for 1986, the year in which invertebrates were sampled from the floodplain, is superimposed over the 1982 plot (Fig. 2C), and describes a particularly dry year (37 m^3/s). Submerged snag surface area ranged from ~0.2 to 0.5 m^2 /m^2 of river bed (Fig. 2B). The variability in submerged snag surfaces (Fig. 2B) was not nearly as great as variability in the mean daily discharge (Fig. 2A), and differences in snag surface between 1982 and 1983 were small. Even at base flow, there was a considerable amount of snag surface submerged because the greatest concentrations of wood were lowest in the water (Wallace and Benke 1984).

Daily floodplain inundation patterns predicted for 1982 and 1983 (Fig. 2C) closely mirrored the discharge pattern (Fig. 2A). Most flooding primarily occurred in winter and spring (Benke et al. 2000). 1983 clearly had much greater floodplain inundation than 1982. The 1986 inundation pattern was similar to that in 1982, except there was no inundation during summer months (Fig. 2C). The long-term pattern of inundation showed substantial variability over the 58-y period (Fig. 3). In some years, there were no floods reaching the 50% inundation level (i.e., 1945, 1950, 1968, and 1988), but such years were rare. Inundation of at least 50% of the floodplain occurred for >2 mo every ~2 y. Compared to the long-term pattern of predictions, 1982 and 1986 were clearly low-inundation years and 1983 was a relatively high-inundation year.

Invertebrate analysis

River channel snags.—Most of the snag inhabitants were aquatic insects, and their biomass usually fluctuated from 2 to 10 g dry mass/m^2 of snag surface (Fig. 4A). Seasonal patterns of the major primary consumers (Diptera, Ephemeroptera, Trichoptera) were not apparent despite strong seasonality in discharge (Fig. 2A). In general, mean habitat-specific density (>97,000/m^2) and biomass (>6.4 g/m^2) were very high (Table 2). Trichoptera dominated the biomass, and Diptera had the highest densities, although Ephemeroptera, Coleoptera, and Ple-

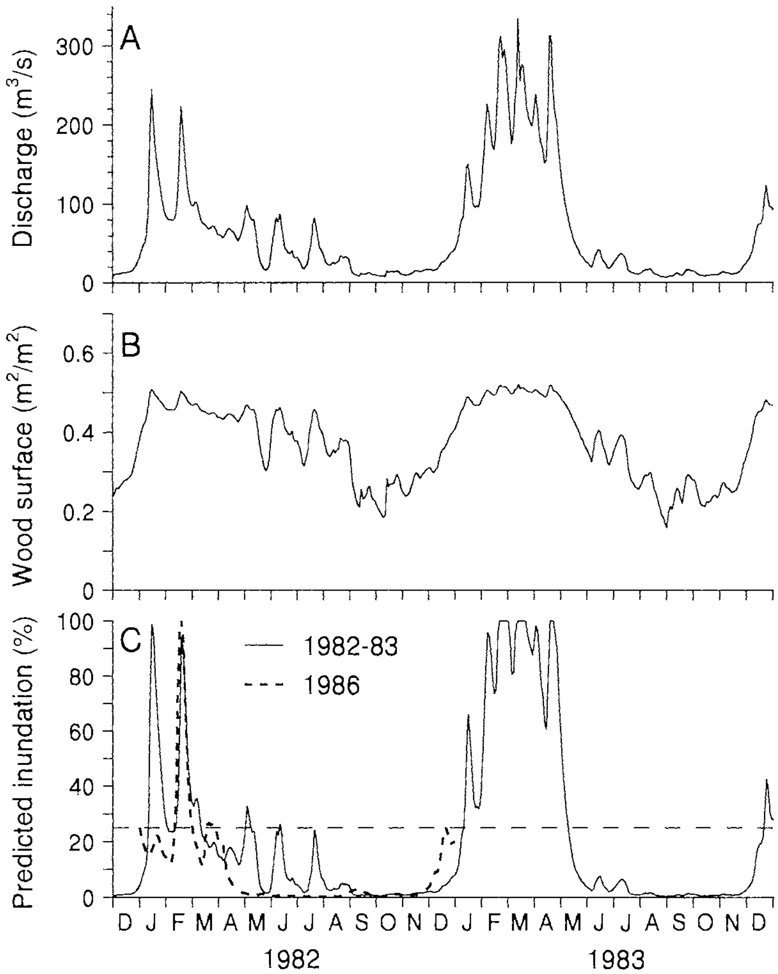

FIG. 2. Two-year pattern of mean daily discharge (A), estimated wood surface area submerged (B), and % of floodplain inundation (C) for the Ogeechee River. Wood surface area (= S_b, as m^2 of wood surface per m^2 of river bed) was predicted from the model $S_b = 0.368\ H^{0.280}$, where H is daily river stage (m) (Wallace and Benke 1984). Percent of floodplain inundation (I) was predicted from the model I = 0.345 D + 1.358, where I = arcsine (% inundation), and D = discharge (m^3/s) (Benke et al. 2000). Dashed line in C represents 25% inundation level, below which the predictive model underestimates inundation. Daily stage and discharge were obtained from US Geological Survey gaging station at Eden, Georgia.

coptera also were well represented (Fig. 4A, Table 2). When snag biomass values were converted to units of river bed (Fig. 4B), temporal patterns were similar to habitat-specific patterns (Fig. 4A), but river bed values were proportionately higher in spring, the result of higher submerged snag surface area at that time (Fig. 2B). The mean density and biomass per river bed were ~⅓ of snag habitat values (Table 2), which would be expected with a wood surface area ranging from ~0.2 to 0.5 m^2/m^2 of river bed (Fig. 2B).

River channel benthic.—The benthic invertebrate assemblage in the main river channel contrasted sharply with the snag assemblage (Table 2). Biomass was dominated by the exotic mollusc *Corbicula fluminea* (3.4 g/m^2), whereas density was dominated by small oligochaetes (>33,000/m^2). Compared with snags, density (~7000/m^2) and biomass (<200 mg/m^2) for benthic insects were low, and consisted mostly of dipterans and coleopterans. Mean values for habitat surface and river bed were identical because no adjustments were made for habitat

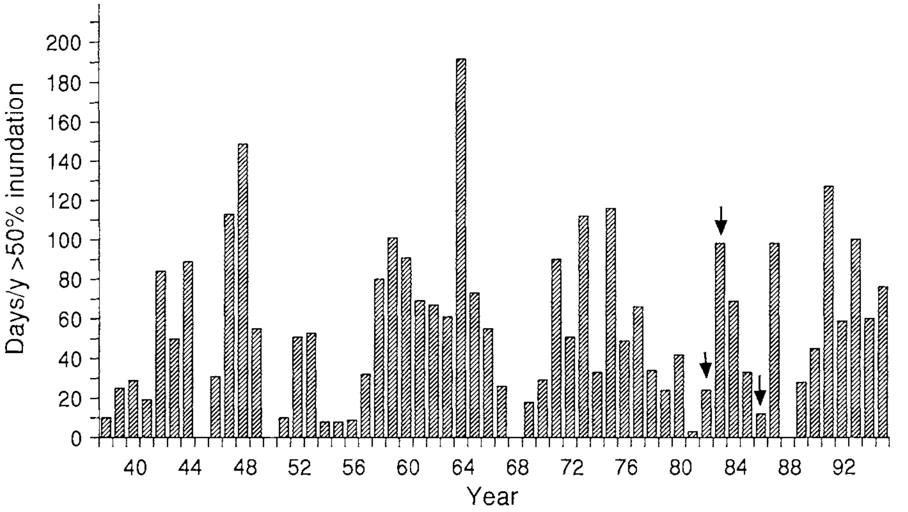

FIG. 3. Days per year for which at least 50% of the floodplain was inundated along a 6.3-km reach of Ogeechee River over a 58-y period (1938–1995). Arrows indicate years invertebrate samples were taken.

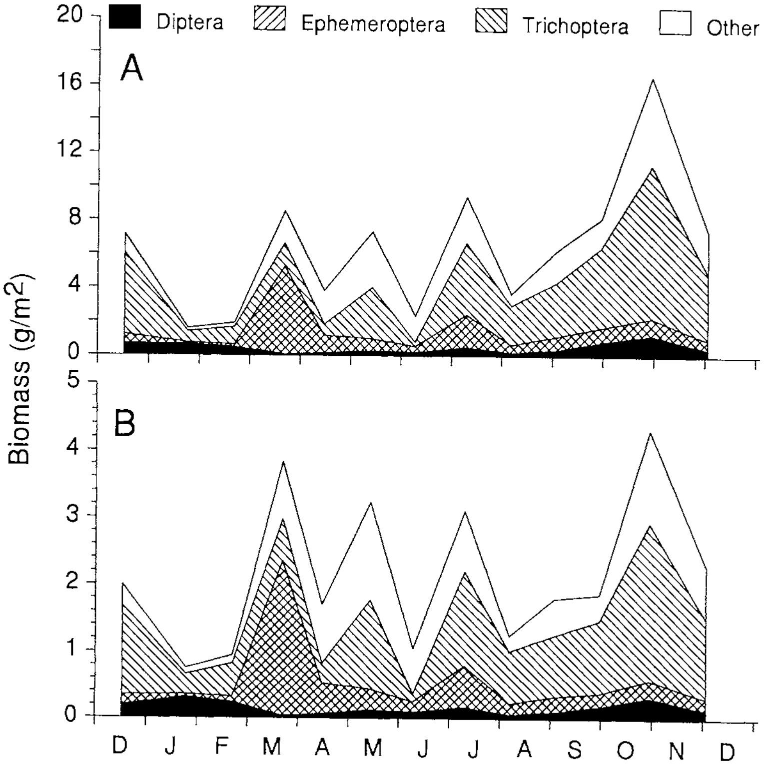

FIG. 4. Dry biomass of major invertebrate groups on the snag habitat for surface area of snag (A), and for area of river bed (B) for 1982. All lines are cumulative. Snag habitat values (A) are converted to river bed values (B) using wood surface area model (Fig. 2, see caption).

TABLE 2. Invertebrate density and dry biomass from channel benthic and snag habitat (1982) and floodplain (1986) converted to m² of river bed for the Ogeechee River. Habitat-specific and river bed values were identical for channel benthic because no adjustments were made for habitat availability.

	Per m² habitat surface		Per m² of river bed		
Habitat/taxon	(no./m²)	(mg/m²)	(no./m²)	(mg/m²)	Source of data
Channel (benthic)					
Mollusca	230	3412	230	3412	Stites et al. 1995
Oligochaeta	33,368	591	33,368	591	Stites 1986, 1987
Diptera	5805	78	5805	78	Stites 1986
Coleoptera	1212	108	1212	108	Stites 1986
Total	40,615	4191	40,615	4191	
Channel (snag)					
Oligochaeta	2290	10	653	3	This study
Diptera	73,583	496	22,052	159	Benke and Parsons 1990, Benke 1998, this study
Coleoptera	3549	591	1085	184	This study
Ephemeroptera	4643	752	1472	291	Jacobi and Benke 1991, Benke and Jacobi 1994
Trichoptera	12,411	3013	3873	959	Benke and Wallace 1997
Plecoptera	1034	672	348	232	Benke et al. 2001
Odonata	12	423	4	141	Benke et al. 2001
Megaloptera	49	427	16	166	Benke et al. 2001
Isopoda	133	17	57	6	This study
Total	97,704	6401	29,560	2141	
Floodplain					This study
Mollusca	20	13	180	119	
Oligochaeta	6161	329	44,660	2910	
Diptera	2953	146	21,142	909	
Isopoda	1606	298	13,267	2386	
Other	220	66	1870	541	
Total	10,960	852	81,119	6865	

availability (Table 2). Thus, temporal patterns for habitat surface and channel bed also were identical (Stites 1986).

Floodplain.—The benthic invertebrate assemblage in the floodplain was different from both snags and benthos of the main channel. Oligochaetes, isopods, and dipterans were the major groups in terms of density and biomass (Table 2). Oligochaete biomass was somewhat lower in the floodplain than in the main channel, whereas dipteran biomass was somewhat higher (Table 2). Total biomass and density were much lower in the floodplain than observed on snags (Table 2, Fig. 5A). Although non-dipteran insects were found in the floodplain (e.g., Ephemeroptera, Plecoptera, Trichoptera), their combined presence was minor compared to their abundance on snags. Unlike the biomass on snags, which showed no strong seasonal trends (Fig. 4), there was a sharp decrease in floodplain biomass from late July through September (Fig. 5A). It should be emphasized that this decline was habitat-specific rather than the result of desiccation (i.e., only sites with water were sampled). Conversion of floodplain biomass to area of river bed yielded numerical and biomass increases of ~8× because of the great areal extent of the floodplain (Table 2, Fig. 5B). The system-level decrease of biomass during summer (Fig. 5B) was partly a result of the habitat-specific decline (Fig. 5A) and partly a result of desiccation of several sampling sites. The decline in floodplain biomass did not occur as early as predicted from the floodplain inundation model (Fig. 2C, 1986) because retention of water by floodplain pools and inputs of rain or groundwater extended the period during which floodplain animals could persist.

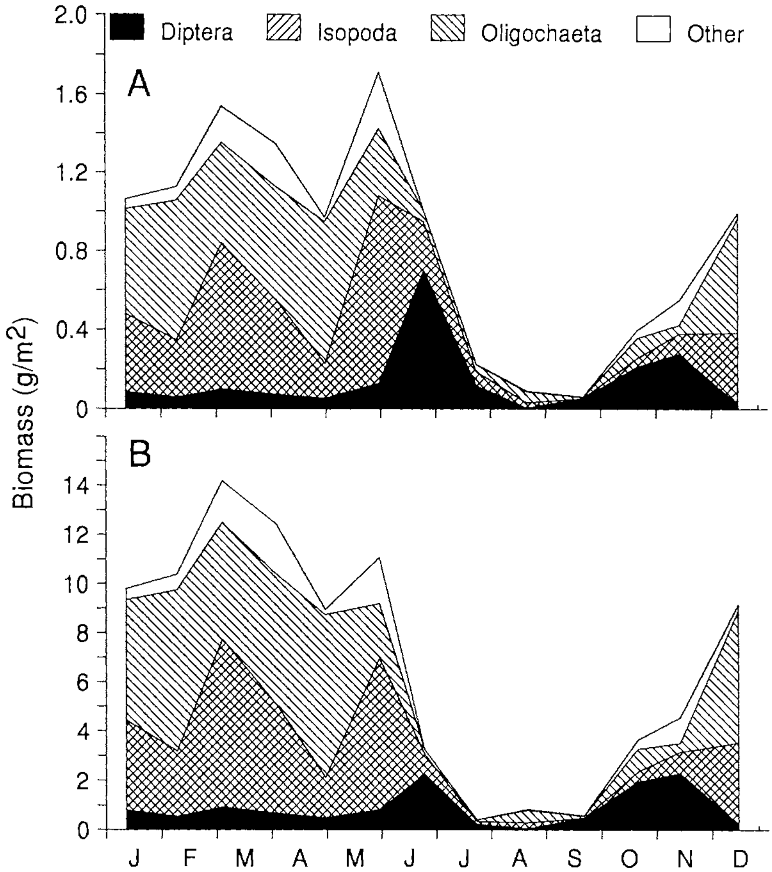

FIG. 5. Dry biomass for major invertebrate groups from the floodplain habitat (A), and after conversion to per m^2 river bed (B) for 1986. All lines are cumulative. Floodplain values were converted to river bed values (B) using field-level approximations because inundation was always <25% when samples were taken in 1986 and the model was unreliable.

Channel, snag, and floodplain.—Conversion of habitat-specific values of invertebrate density and biomass to a standard unit (per m^2 of river bed) provided a means of comparing system-level values among habitats. Although estimates of specific invertebrate groups (mostly order level) are summarized in Table 2, the distribution of biomass among the major groups (Arthropoda, Oligochaeta, and Mollusca) within each habitat and per m^2 of river bed is more clearly illustrated in Fig. 6. For habitat surface values, biomass on snags (almost entirely insects) was ~8× higher than in the benthic habitats in the floodplain or river channel (excluding *Corbicula*). When values were converted to river bed area, the greater area of the floodplain resulted in the highest invertebrate biomass contribution coming from floodplain arthropods (mostly isopods) and oligochaetes.

Invertebrate drift.—Drifting invertebrates consisted primarily of those taxa (e.g., Ephemeroptera, Trichoptera, Plecoptera and Odonata) found on the snag habitat (Table 3). Dipterans and coleopterans also probably originated mostly from snags, although some also could have come from the benthic habitat of the channel or floodplain (Table 2). Unlike snags, which lacked a temporal pattern in biomass (Fig. 4), there were strong seasonal patterns to drift, with major peaks occurring during winter–spring, the period of highest discharge (Benke et al. 1991). Drift densities (>20/m^3) and biomass (2.4 mg/m^3) were high in 1982 (Table 3), with values almost identical to 1983, a year with much higher

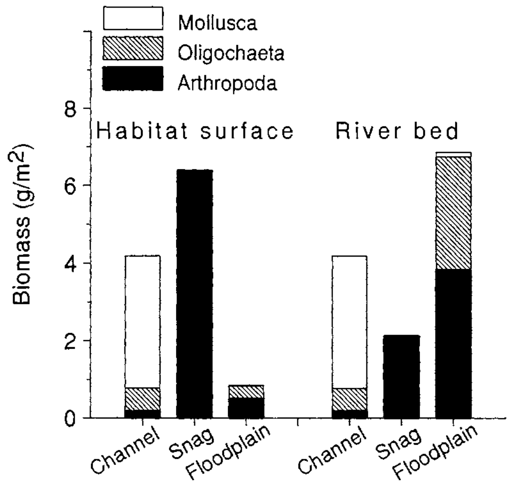

FIG. 6. Comparison of invertebrate dry biomass in river channel, snag, and floodplain habitats per habitat surface area and after conversion to area of river bed. Conversion to area of river bed demonstrates the same relationship as relative amounts of biomass per length of river.

TABLE 3. Invertebrate drift density and biomass for major invertebrate groups in the Ogeechee River for 1982 (Benke et al. 1991). Crustacea includes Copepoda, Cladocera, Isopoda, Amphipoda, and Ostracoda (arranged by density from highest to lowest). Miscellaneous primarily includes Hydracarina, Oligochaeta, and Mollusca. S = snag, CB = channel benthic, F = floodplain. – = biomass conversions not available.

Taxonomic group	Habitat origin	Density (no./100 m^3)	Biomass (mg/100 m^3)
Diptera	S, CB, F	508.7	22.0
Coleoptera	S, CB	115.3	57.2
Ephemeroptera	S	286.4	72.4
Trichoptera	S	214.1	42.4
Plecoptera	S	183.2	32.2
Odonata	S	19.2	10.7
Megaloptera	S	0.3	1.5
Crustacea	S, CB, F	593.5	4.5
Miscellaneous	S, CB, F	124.6	–
Total		2055.3	242.9

discharge (Benke et al. 1991). Although crustaceans composed almost 30% of drift density, they represented <2% of drift biomass; cladocerans and copepods (zooplankton) contributed only 1% to drift biomass.

Discussion

Studies of the Ogeechee River illustrate that ecological understanding of low-gradient rivers cannot be achieved by attention to the river bed alone. Much of the biological activity occurs along the bank (snags) and well into the floodplain. Our attention to snags and floodplain represents a significant departure from the small-stream paradigm that focuses on habitats characterized by size distribution of mineral substrates and their associated current velocities (e.g., Huryn and Wallace 1987, Hawkins et al. 1993, but see Smock et al. 1992). Documentation of the importance of snags to invertebrates reinforces previous findings from the southeastern USA Coastal Plain (e.g., Cudney and Wallace 1980, Benke et al. 1984, Smock et al. 1985, 1992), and studies from other regions of the world (e.g., Anderson et al. 1978, O'Connor 1992, Spänhoff et al. 2000). However, the system-level assessment also shows that floodplain habitats can represent a very important site for invertebrate populations, even during drought years. This pattern is likely to be true of many rivers in which floodplain width greatly exceeds channel width, regardless of latitude, but less true for rivers where the natural floodplain is relatively narrow or where regulation or navigation structures have been installed (e.g., Thorp et al. 1998). Clearly, the relative contributions of habitats and natural inundation regime must be assessed in any river–floodplain ecosystem to understand its natural functioning.

Riverine hydrology and habitats

The Ogeechee is a good example of how climate, geology, and geomorphology ultimately define any river–floodplain ecosystem (e.g., Benke et al. 1988). The strongly seasonal temperature and evapotranspiration patterns in the southeastern USA are the major factors that generate winter–spring flooding (Muller and Grymes 1998, Benke et al. 2000). Such temperature and hydrological regimes, along with physical aspects of floodplain topography and soils, provide the environment within which floodplain forests flourish (Kellison et al. 1998).

The floodplain forest and hydrological regime together define the physical habitats essential for aquatic animal populations in the Ogeechee

River. Bankside trees provide a continuous source of snag material to the channel (Wallace and Benke 1984, Cuffney 1988, Benke and Wallace 1990), and river stage determines how much snag habitat is colonized at any one time (Fig. 2B). The rest of the floodplain vegetation helps define and stabilize habitats over an area 37× the river channel width, and its primary production in the form of litterfall (Table 1) ultimately fuels food webs in both the floodplain and river channel (e.g., Wallace et al. 1987, Cuffney 1988, Wainright et al. 1992, Carlough 1994).

Analysis of inundation patterns in the Ogeechee River showed that knowledge of both short-term and long-term hydrology is necessary for understanding the dynamics and function of floodplain rivers. Although the winter–spring pattern of flooding is predictable (e.g., Fig. 2C), the magnitude varies considerably among years (Fig. 3). Furthermore, floods of high magnitude during winter–spring typically have a relatively long duration (i.e., >30 d), whereas unpredictable floods in summer–autumn are of shorter duration (Benke et al. 2000).

Although the hydrological regime and floodplain vegetation of the Ogeechee River are probably similar to many rivers of the southeastern USA (e.g., Kellison et al. 1998), they are not universal for all river–floodplain ecosystems (Benke et al. 2000). For example, seasonal rainfall rather than seasonal variation in evapotranspiration drives the flood pulse of many tropical systems (e.g., Irion et al. 1997), in which duration of inundation is typically longer and more predictable than found in the Ogeechee (e.g., Hamilton et al. 1996, Sippel et al. 1998). Instead of a forested swamp, vegetation in many tropical floodplains consists of small aquatic and semiaquatic plants (e.g., Hamilton et al. 1996, Junk and Piedade 1997). Regardless of regional characteristics, however, flood regimes play a vital role in defining aquatic habitats for fauna.

Habitat-specific vs systems-level contributions of invertebrates

Arthropod biomass on snags in the Ogeechee River (i.e., 6.4 g dry mass/m^2, Table 2) was very high compared to biomass in other lotic systems. This high biomass, and production/biomass values >100 for some taxa such as dipteran larvae, translate into extremely high invertebrate production (e.g., Benke and Wallace 1997, Benke 1998). The lack of seasonality in biomass of major insect orders on snags (Fig. 4) suggests a high stability of this assemblage despite great variation in discharge (Fig. 2A). This stability is conferred by a high diversity of species, of which many have seasonal, but complementary, biomass patterns (e.g., Benke and Jacobi 1994, Benke and Wallace 1997).

Invertebrate biomass in the benthic habitat of the main channel and the floodplain swamp were low in comparison to those of snags (Table 2). However, habitat-specific biomass of the channel benthos is comparable to biomass on snags if the slow-growing exotic mollusc *Corbicula* is included. The low biomass in the Ogeechee floodplain (0.85 g/m^2, Table 2) was similar to values obtained in 2 small-stream floodplains in Virginia (Gladden and Smock 1990, Smock et al. 1992). The ephemeral nature of floodplain habitats is probably a major reason that habitat-specific diversity and production are not nearly as high as that found on snags. High variation in the magnitude and duration of floods between and within years poses physiological challenges for floodplain invertebrates. Short development times, as for aquatic dipterans (e.g., Stites and Benke 1989, Hauer and Benke 1991, Nolte 1995), or desiccation-resistant adaptations, as for aquatic dipterans, microcrustaceans, and molluscs (e.g., Grodhaus 1980, Edward 1986, Armitage et al. 1995, Smock 1999), are necessary for survival in environments with such habitat shrinkage.

At the system level, invertebrate biomass was highest in the floodplain because of its large surface area (Fig. 6, Table 2), a similar finding to Smock et al. (1992) in their Virginia streams. The importance of floodplain habitat in the Ogeechee is particularly apparent if one considers the fact that invertebrates were collected in a very dry year when flooding was minimal. However, the strong seasonality of biomass (Fig. 5) resulting from great fluctuations in inundation (Fig. 2C) demonstrates that the floodplain invertebrate assemblage is less stable than that found on snags. In years when the floodplain receives much greater inundation during winter–spring (e.g., 1983, Fig. 2C), it is likely that aquatic invertebrate abundance in the floodplain will increase substantially. In contrast, when even modest inundation occurs during summer months (e.g., 1982, Fig. 2C), the summer decline in habitat-specific biomass observed in 1986 (Fig. 5A) should not be as extreme.

A major distinction between small-stream versus large-river ecology concerns analysis of invertebrates in the water column. Stream research generally focuses on the phenomenon of drift by benthic invertebrates (e.g., Waters 1972) and large-river research increasingly focuses on zooplankton (e.g., Thorp et al. 1994). The question of what natural and human factors affect the absolute and relative amounts of drift vs zooplankton deserves attention because this distinction ultimately defines structure of the riverine food web. Drift density and biomass in the Ogeechee River were relatively high compared with drift from other lotic systems of any size, largely because of contributions from the snag habitat (Table 3; Benke et al. 1991). In contrast, zooplankton (cladocerans and copopods) only composed ~1% of total drift biomass (0.03 μg/L), and was much lower than levels found in many other rivers (e.g., Pace et al. 1992, Thorp et al. 1994, Basu and Pick 1996). Thus, the 6th-order Ogeechee River appears more similar to small streams than to large rivers in terms of water-column invertebrates. In addition, the relatively minor contributions of floodplain macroinvertebrates (e.g., isopods) or microcrustaceans (Anderson 1995) to channel drift biomass in both dry (1982) and wet (1983) years suggests that current velocities in the floodplain during most floods (<20 cm/s, Roberts et al. 1985) were insufficient to flush much of the invertebrate production from this wide floodplain into the river.

Although floodplain invertebrates may not be transported into the main channel of the Ogeechee River on a regular basis, the exchange of water, nutrients, and other organic matter between river channel and floodplain is nonetheless a critical connection (e.g., Junk et al. 1989, Bayley 1995). Attempts to quantify such exchanges are rare, but movement of coarse particulate and dissolved organic matter from the Ogeechee floodplain represents a significant input to the channel (Table 1; Cuffney 1988, Meyer et al. 1997). The high biomass and production of snag-dwelling insects is made possible by an abundant supply of microbially enriched amorphous detritus that primarily originates from the floodplain forest (Edwards and Meyer 1990, Couch and Meyer 1992, Wainright et al. 1992, Carlough 1994). Although invertebrates from the channel bottom and floodplain may use similar food resources, the continuous delivery of sestonic food to a stable snag habitat is much more conducive to high diversity and production than either shifting sand or ephemeral floodplain habitat. It is clear that many fish populations from southeastern Coastal Plain rivers rely on insects on snags and in drift for food (Benke et al. 1985). For at least a portion of the year, however, the floodplain becomes an important part of the aquatic system food web as fishes migrate into these habitats and use the vast invertebrate food resource (flood pulse concept: Junk et al. 1989; Fig. 6).

Management—snag removal, drainage, and flow regulation

Most low-gradient rivers of the southeastern USA have a history of poor management. In contrast to high-gradient streams and rivers that often are regulated by large dams, low-gradient rivers have had snags removed and have been channelized for navigation and flood control (Wallace and Benke 1984). Sometimes low-head dams and locks have been installed for navigation (e.g., Koebel 1995, Thorp et al. 1998). Floodplains have been drained, deforested, and often converted to agriculture. Such projects have rarely considered ecological consequences, and the current Kissimmee River restoration in Florida shows how costly ecological ignorance can be (Koebel 1995). The Ogeechee River is one of the few rivers that have been spared in the southeastern USA (Benke 1990). Although the Ogeechee is small compared to the world's largest rivers, it is one of the largest free-flowing rivers in the contiguous 48 United States, and thus may provide insight into the restoration and management of large regulated rivers.

The integrity of floodplain forests and their importance in creating snag and floodplain habitat is not limited to the southeastern USA or rivers the size of the Ogeechee. Snags and logjams on the Red River and Missouri River in the midwestern USA were notorious as impediments to navigation before their ecological value was recognized (McCall 1988, Botkin 1999). Snags and logjams have been removed from many low-gradient rivers for at least 2 centuries (e.g., Sedell et al. 1982, Wallace and Benke 1984, Gippel et al. 1996). Snags along the main channel of extremely wide rivers may contribute less biological diversity and production than in the Ogeechee River, but floodplain habitats and snags within side channels are still likely to be important.

Unregulated rivers with natural floodplains and flood regimes can serve as benchmarks in attempts to restore natural functioning to altered river systems. Several recent reviews have emphasized the importance of reestablishing natural flow regimes, rather than just minimum flows, in regulated systems (e.g., Poff et al. 1997, Sparks et al. 1998, Galat et al. 1998, Molles et al. 1998, Toth et al. 1998). Studies on the Ogeechee reinforce this view, but further emphasize the need for: 1) establishing flows that result in natural floodplain inundation, and 2) restoring natural habitats such as snags and floodplain forests that are supported by such flows. Neither one of these actions will be of much value in ecosystem restoration if the other is ignored. Maintaining the connection between the river channel and floodplain is vital for diverse and productive invertebrate assemblages and the higher trophic levels that depend on them.

Acknowledgments

Thanks to my colleagues, Judy Meyer, Bruce Wallace, Lloyd Dunn, and Phil Roberts, and their students, whose research provided complementary data for our invertebrate studies on the Ogeechee River project. Thanks to my technician Keith Parsons, and students David Stites, David Jacobi, David Anderson, and Terry Richardson, who played significant roles in the collection and analysis of invertebrate data. Indrajeet Chaubey provided essential assistance in the analysis of the floodplain inundation data. Erin Eppling (GIS Laboratory, Department of Biological Sciences, University of Alabama) produced Figure 1. I also appreciate the constructive comments of Jack Feminella, David Rosenberg, and 2 anonymous reviewers. This research was supported by grants DEB-8104427 and BSR-8406630 from the National Science Foundation.

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Received: 13 September 1999
Accepted: 28 December 2000

RIVER RESEARCH AND APPLICATIONS

River Res. Applic. **29**: 1110–1118 (2013)

Published online 4 September 2012 in Wiley Online Library
(wileyonlinelibrary.com) DOI: 10.1002/rra.2604

FISH RECRUITMENT IS INFLUENCED BY RIVER FLOWS AND FLOODPLAIN INUNDATION AT APALACHICOLA RIVER, FLORIDA

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ABSTRACT

High human demand for limited water resources often results in water allocation trade-offs between human needs and natural flow regimes. Therefore, knowledge of ecosystem function in response to varying streamflow conditions is necessary for informing water allocation decisions. Our objective was to evaluate relationships between river flow and fish recruitment and growth patterns at the Apalachicola River, Florida, a regulated river, during 2003–2010. To test relationships of fish recruitment and growth as responses to river discharge, we used linear regression of (i) empirical catch in fall, (ii) back-calculated catch, via cohort-specific catch curves, and (iii) mean total length in fall of age 0 largemouth bass *Micropterus salmoides*, redear sunfish *Lepomis microlophus* and spotted sucker *Minytrema melanops* against spring–summer discharge measures in Apalachicola River. Empirical catch rates in fall for all three species showed positive and significant relationships to river discharge that sustained floodplain inundation during spring–summer. Back-calculated catch at age 0 for the same species showed positive relationships to discharge measures, but possibly because of low sample sizes ($n = 4$–6), these linear regressions were not statistically significant. Mean total length for age 0 largemouth bass in fall showed a positive and significant relationship to spring–summer discharge; however, size in fall for age 0 redear sunfish and spotted sucker showed no relation to spring–summer discharge. Our results showed clear linkages among river discharge, floodplain inundation and fish recruitment, and they have implications for water management and allocation in the Apalachicola River basin. Managed flow regimes that reduce the frequency and duration of floodplain inundation during spring–summer will likely reduce stream fish recruitment. Copyright © 2012 John Wiley & Sons, Ltd.

KEY WORDS: fish recruitment; floodplain inundation; river fish monitoring; streamflow management; largemouth bass *Micropterus salmoides*; redear sunfish *Lepomis microlophus*; spotted sucker *Minytrema melanops*

Received 25 June 2012; Accepted 31 July 2012

INTRODUCTION

Water allocation and operation of regulated rivers has become an increasingly contentious subject worldwide, primarily because of increasing competition between human users of aquatic ecosystems and regulatory mandates to maintain ecological integrity of aquatic ecosystems (Poff *et al*., 2003). With the increasing freshwater demand by humans commonly surpassing supply in many river basins, trade-offs among water allocation options become inevitable. Informed water allocation practices and policies depend on understanding how aquatic ecosystems function under natural flow regimes as well as knowledge of ecosystem response to flow modification (Richter *et al*., 2003).

Streamflow is considered to be among the most influential factors that shape biotic communities in lotic environments (Poff and Ward, 1989; Poff *et al*., 1997). It can influence community structure (Stanford and Ward, 1983, Rogers *et al*., 2005) as well as growth (Sammons and Maceina, 2009), reproduction (Smith *et al*., 2005) and mortality (Tramer, 1978) of stream biota. As regulation of rivers has increased, there is a large and growing body of research that has demonstrated responses of aquatic ecosystems to modified streamflow (Murchie *et al*., 2008).

In low-gradient river floodplain systems, wet season high flows usually provide annual connectivity and inundation of the floodplain (Welcomme, 1979). Annual flooding is considered to be a major driver of productivity in river floodplain systems (Junk *et al*., 1989), and it is common that fish species in these systems display behavioral adaptations to exploit annual flooding events (Welcomme, 1979; Bayley, 1988; Kwak, 1988; Balcombe *et al*., 2005). Commonly, fish in river floodplain systems respond to rising water levels and floodplain inundation as cues for spawning (Agostinho *et al*., 2004). As spawning and nursery habitat for river fish assemblages, inundated floodplain habitats provide food and complex cover for refuge from predation (Balcombe *et al*., 2005). Consequently, annual variation in fish recruitment

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is often influenced by river water level and floodplain inundation (Raibley *et al*., 1997; DiCenzo and Duval, 2002; Smith *et al*., 2005; Janac *et al*., 2010).

The Apalachicola River is a highly regulated river in Florida with a large, undeveloped floodplain. Wet season high flows in the Apalachicola River historically provided annual periods of inundation and connectivity to floodplain habitats (Light *et al*., 1998). Although the magnitude and the duration of floodplain inundation vary from year to year, some degree of floodplain inundation has occurred with near-annual regularity, and the ecology of floodplain biota is reflective of regular flooding (Light *et al*., 1998). Considering the pervasive linkage of fish productivity and river floodplain inundation in other large river–floodplain systems (Welcomme, 1979), this relationship may extend to the fish assemblage at Apalachicola River as well, and the annual degree of floodplain inundation may influence stream fish population vital rates, such as recruitment and growth. However, recent research has shown that the frequency and the magnitude of floodplain inundation have declined in recent years at Apalachicola River relative to historical records (Light *et al*., 2006). These results cause significant concerns because decreases in connectivity between river main stem and floodplain habitats may lead to reduced ecosystem function or loss of biodiversity in these habitats (Ward *et al*., 1999). In light of this downward trend in floodplain inundation and ongoing debates over water management and allocation within the Apalachicola–Chattahoochee–Flint (ACF) river system, our objectives were to determine fish and streamflow relationships at Apalachicola River by relating indices of fish recruitment and measures of age 0 fish growth to river discharge and floodplain inundation. The understanding of the relationship of interannual fluctuations in fish recruitment and condition relative to river discharge will help resource managers gauge the potential effects of managed flow regimes.

STUDY AREA

The Apalachicola River is the largest river in Florida in terms of mean annual discharge [630 $m^3 \cdot s^{-1}$ (22,300 $ft^3 \cdot s^{-1}$); Light *et al*., 1998]. It is formed by the confluence of the Chattahoochee and Flint rivers near the Florida–Georgia border and flows 170 km through the Florida panhandle to the Gulf of Mexico (Figure 1). In total, the ACF basin encompasses an area of approximately 50,700 km^2, and it includes 16 dams (Ward *et al*., 2005). Jim Woodruff Lock and Dam, the most downstream dam in the ACF basin, impounds the confluence of the Chattahoochee and Flint rivers (forming Lake Seminole in 1957), and its discharge marks the beginning of the Apalachicola River. Owing to the extensive dam complex within its basin, streamflow in the Apalachicola River is highly regulated.

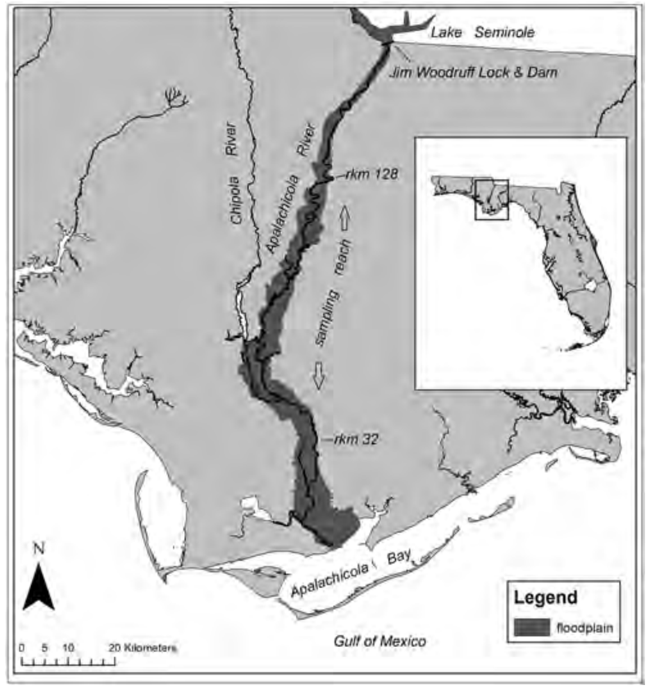

Figure 1. Map of Apalachicola River and its adjacent floodplain, with sampling reach denoted (32–128 rkm). Spatial data for the Apalachicola River floodplain was derived from a forest map by Leitman (1984) that was digitized and modified for use by Darst and Light (2008)

The Apalachicola River floodplain is the largest river floodplain in Florida, and having minimal development, it remains one of the most the most extensively forested floodplains in the contiguous United States. The freshwater, nontidal floodplain ranges from 1.6 to 8 km in width and represents an area of roughly 332 km^2 (Light *et al*., 1998). Floodplain habitats range from deep and often connected oxbow lakes to Tupelo-cypress (*Nyssa aquatic*, *Nyssa ogeche* and *Taxodium distichum*) swamps to mixed bottomland forests (Light *et al*., 1998). Typically, highest flows occur in the Apalachicola River during late winter and spring (January–April). This seasonal window of high flows varies in magnitude and duration yet provides inundation of some portion of floodplain habitats during most years (for further explanation of the relationship of river discharge and floodplain inundation, see Discharge Measurement section; Light *et al*., 1998).

The freshwater fish assemblage of the Apalachicola river–floodplain system is one of the most diverse of all Florida rivers (Bass, 1983). Basin-wide, there have been 116 fish species documented, and within the Apalachicola River section (below Jim Woodruff Lock and Dam), 86 species have been found (Yerger, 1977; Bass, 1983). A large proportion of these fishes (80%) have been linked to

DOI: 10.1002/rra

floodplain habitats at some point during their life history (Light *et al*., 1998). At least 45 species are known to use the Apalachicola River floodplain for spawning and nursery habitats based on larval fish light trap collections from 2002 to 2007 (Walsh *et al*., 2009; Burgess *et al*., 2012). Therefore, the connection and the inundation of floodplain habitats are most likely very important in shaping the structure of the freshwater fish assemblage at Apalachicola River.

METHODS

Fish collection

We sampled stream fish at Apalachicola River with boat electrofishing during September and October of each year during 2003–2010. Our sampling spanned from river kilometer (rkm) 128, where floodplain expansion begins, downstream to rkm 32, which excluded areas of tidal influence in the lower river (Figure 1). We used 10-min electrofishing transects as sampling replicates for measuring fish catch per unit effort (CPUE). To ensure that our sampling was representative of the overall fish assemblage, our sampling effort was stratified equally between main stem and connected backwater habitats (50 transects each; 100 transects total per year), as many species routinely migrate between these habitats (Burgess *et al*., 2012). For each year of sampling, we randomly reselected sampling transect locations within each of the two strata. Our electrofishing sampling was focused exclusively toward shoreline habitats ($\leq$10 m from bank). Habitats along channel margins generally included sandbars, overhanging riparian vegetation, woody debris or exposed cypress root structures. During sampling, we encountered depths that ranged from less than 0.5 m, along inside river bends, to 6 m, along outside river bends. Habitat composition and depth varied within sampling transects as well as among sampling transects during each year; however, the suite of conditions for each variable was similar among years of sampling. Our boat electrofisher used two bow-mounted anode arrays, spaced 2 m apart, and two bow-positioned netters. Electrical output (pulsed direct current, 60 Hz) was standardized to produce approximately 6000 W of potential energy transfer to targeted fish. All fish collected were identified to species and measured for total length (TL) and weight, except for during preliminary sampling in 2003–2004, when only largemouth bass *Micropterus salmoides* were enumerated.

Fish aging

We selected largemouth bass, redear sunfish *Lepomis microlophus*, and spotted sucker *Minytrema melanops* as species for which recruitment could be related to river discharge. These species were selected because they are native to the ACF basin, relatively common and represent different feeding guilds or trophic levels within the fish assemblage (largemouth bass, piscivore; redear sunfish, insectivore/molluscivore; spotted sucker, algivore/detritivore). To construct age-length keys (Ricker, 1975), we retained approximately 10 individuals per 1-cm size group for aging during each sampling season. To ensure that our age-length keys were representative of the overall population of each species within the river, we generally used equal contributions of individuals from main stem and backwater strata for aging analyses. In addition, to reduce any potential biases of a single locale, individuals retained for aging were generally selected from different sampling transects. We aged largemouth bass and redear sunfish by counting annular rings in whole and transverse sectioned sagittal otoliths via dissecting microscopes. To age spotted sucker, we counted annular rings of whole and sectioned lapilli otoliths. The verification of annular ring formation in largemouth bass otoliths was established by Taubert and Tranquilli (1982), and the validation of these methods for aging largemouth bass was conducted by Hoyer *et al*. (1985). Verification that rings in redear sunfish sagittal otoliths are formed annually and that interpretation of these rings is a valid estimator of age was established by Mantini *et al*. (1992). For spotted sucker, the use of otolith annuli as an age estimator has not been yet validated in peer-reviewed literature. However, monthly marginal increment analyses of spotted sucker at Apalachicola River, Florida indicated that ring formation in lapilli otoliths occurred on an annual cycle (Strickland PA, unpublished research). Furthermore, the use of annular rings in lapilli otoliths has been used as an age estimator in other Catostomidae species (Thompson and Beckman, 1995; Terwilliger *et al*., 2010). Therefore, we interpreted rings on spotted sucker as annuli for this study.

Discharge measurement

Apalachicola River discharge data were provided by the US Geological Survey as measured at the long-term surface-water gauge near Chattahoochee, Florida (station number 02358000), located 1 km downstream of Jim Woodruff Lock and Dam. Our measure of streamflow was the proportion of days during 1 March–30 September when mean daily discharge was $\geq$460 $m^3 \cdot s^{-1}$ (16,400 $ft^3 \cdot s^{-1}$). The discharge criterion of 460 $m^3 \cdot s^{-1}$ corresponds to the median daily discharge during 1922–1995, and it is close to an inflection point in the relationship of discharge and floodplain inundation, which occurs at approximately 370–400 $m^3 \cdot s^{-1}$ (13,000-14,000 $ft^3 \cdot s^{-1}$; Light *et al*., 1998). Lower than 370 $m^3 \cdot s^{-1}$, less than 3% of the floodplain is inundated, and discharge is largely confined within the channels of the Apalachicola main stem and major tributaries. Higher than 370 $m^3 \cdot s^{-1}$, discharge increasingly inundates floodplain

DOI: 10.1002/rra

habitats (Light *et al.*, 1998). The median daily discharge value ($460\,m^3{\cdot}s^{-1}$) that we used as a discharge criterion is slightly above the inflection point in the relationship of discharge and floodplain inundation and corresponds to inundation of approximately 10% of the Apalachicola River floodplain (Light *et al.*, 1998). The temporal window of our discharge criterion begins in March, typically the onset of stream fish spawning in Apalachicola River (Pine *et al.*, 2006; Walsh *et al.*, 2009; Burgess *et al.*, 2012), and includes flows affecting young-of-the-year fishes until the onset of annual sampling in the fall.

Analyses

We used linear regression to assess the relationship of fish recruitment as a response to Apalachicola River discharge during spring and summer. We used two methods of indexing recruit abundance: (i) empirical measures of age 0 electrofishing CPUE (individuals per hour) and (ii) back-calculated estimates of age 0 CPUE via cohort-specific catch curves. Because we collected age-specific catch data during six consecutive years, we were able to track relative abundance of multiple cohorts through time; thus, enabling use of cohort-specific catch curves (Tetzlaff *et al.*, 2011). Also, the empirical CPUE of age 0 fish could be influenced by annual changes in the catchability of young, small fish. Therefore, we used the back-calculated method as a second method to evaluate trends. Cohort-specific catch curves consisted of the linear regression of $\log_e$ transformed mean CPUE as a response to cohort age. We used the *y*-axis intercept of the linear regression equation for each cohort-specific catch curve as the back-calculated catch of that cohort at age 0. In our analyses, we only included back-calculated recruit indices that were calculated from cohort-specific catch curves that had three or more years of consecutive catch and showed significant and negative linear regression lines (i.e. an indication of mortality). To be valid, the method of back calculation of recruit abundance via cohort-specific catch curves assumes (i) survival is constant among years, (ii) catches are proportional to abundance, (iii) effort is consistent among years or catch is standardized relative to effort and (iv) annual sampling catchability is constant (Tetzlaff *et al.*, 2011). This method improves the accuracy of recruitment indices over catch curves conducted across cohorts (Tetzlaff *et al.*, 2011), and it provided an additional measure of recruitment to the annual age 0 CPUE data. We considered linear regression lines to be significant at $\alpha = 0.1$.

In addition to evaluating juvenile abundance indices as a response to river discharge, we also evaluated juvenile stream fish growth as a response to river discharge. Specifically, we used linear regression to evaluate mean TL in fall of age 0 individuals as a response to a spring–summer discharge metric. Our use of relative abundance of age 0 fishes (empirical CPUE) in fall as an index of recruitment for each year assumes similar over-wintering survival among years. However, because size-specific survival can be influential to juvenile cohorts, high juvenile abundance alone does not necessarily infer higher recruitment (e.g. Van Horne, 1983). In other words, a juvenile cohort could be very abundant in the fall but occur at smaller than normal body size and suffer a higher than normal overwinter mortality rate, reducing the cohort's actual contribution to the adult population. Therefore, knowledge of the relationship of age 0 stream fish size in fall and spring–summer discharge patterns would provide insight to the validity of drawing inferences from abundance of juvenile fish cohorts in fall.

RESULTS

We sampled largemouth bass from 2003 to 2010, and during that time frame, empirical catch rates of age 0 largemouth bass (individuals per hour) ranged from 6.19 (2004) to 54.93 (2005). Redear sunfish and spotted sucker were sampled during 2005–2010. During that time frame, the age 0 catch rates of redear sunfish ranged from 0.12 (2007) to 15.28 (2005) and those of spotted sucker ranged from 0.12 (2010) to 9.73 (2009). Apalachicola River discharge measures (proportion of days with discharge $\geq 460\,m^3{\cdot}s^{-1}$) during spring and summer of sampling years ranged from 0.09 (2007) to 0.89 (2003), indicating both persistently high and low streamflow conditions during our study duration. Linear regression showed a positive and significant relationship between age 0 catch and spring–summer river discharge for all three of the species investigated (all $P \leq 0.0691$; Table I; Figure 2, left panels).

Back-calculated catch of age 0 fish abundance had lower sample size than the age 0 fish CPUE data, but the results generally corroborated the age 0 CPUE catches (Table I; Figure 2). Back-calculated catch of age 0 largemouth bass included cohorts from 2001 to 2006 and ranged from 11.71 (2001) to 63.70 (2003). For redear sunfish, back-calculated catch included 2003–2006 cohorts and ranged from 3.48 (2006) to 62.24 (2003). For spotted sucker, back-calculated catch included cohorts 2002–2004 and 2006 and ranged from 4.98 (2006) to 85.56 (2003). Spring–summer discharge measures (proportion of days $\geq 460\,m^3{\cdot}s^{-1}$) that corresponded to back-calculated catch ranged from 0.12 (2002) to 0.89 (2003), indicating high and low streamflow periods, were encompassed in time frames for back-calculated catch. Linear regression lines for back-calculated age 0 catch against spring–summer river discharge showed positive relationships; however, linear models were not significantly different from a zero slope

DOI: 10.1002/rra

Table I. Linear regression equations for catch of age 0 stream fish and Apalachicola River discharge (proportion of days during 1 March–30 September when mean daily discharge ≥ 460 $m^3 \cdot s^{-1}$) for each species and abundance estimation method with R^2, P and n

Species	Recruitment metric	Regression equation	R^2	P	n
Largemouth bass	Empirical CPUE	Age 0 CPUE = 50.149 × Discharge + 1.252	0.73	0.0068	8
	Back-calculated CPUE	Age 0 CPUE = 37.514 × Discharge + 14.153	0.41	0.1689	6
Redear sunfish	Empirical CPUE	Age 0 CPUE = 20.199 × Discharge − 2.383	0.73	0.0311	6
	Back-calculated CPUE	Age 0 CPUE = 26.086 × Discharge + 24.711	0.15	0.6120	4
Spotted sucker	Empirical CPUE	Age 0 CPUE = 12.881 × Discharge − 1.258	0.60	0.0691	6
	Back-calculated CPUE	Age 0 CPUE = 85.174 × Discharge + 7.764	0.65	0.1933	4

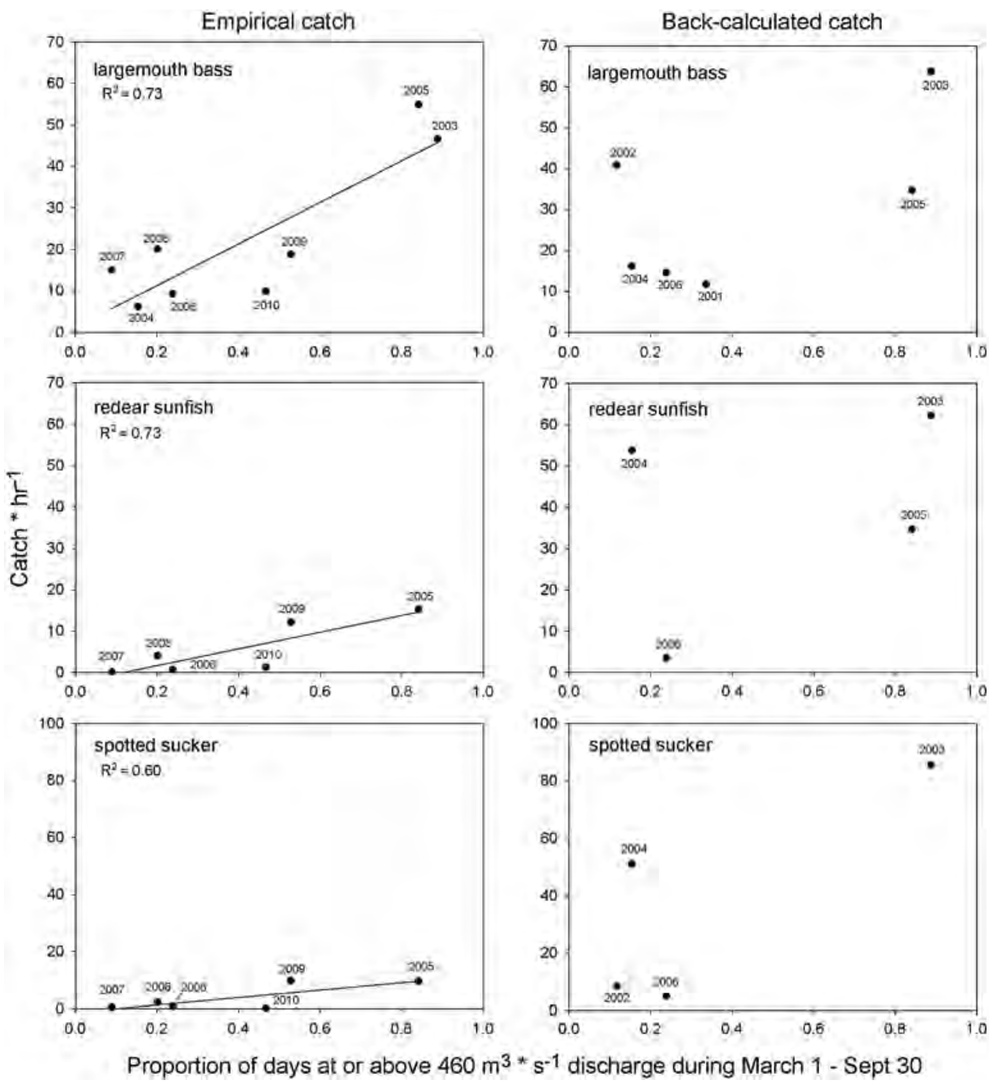

Figure 2. Plots of age 0 stream fish catch during fall against spring–summer river discharge at Apalachicola River, Florida. Empirical catch rates are shown in the left panels, and back-calculated catch rates are shown in the right panels. Only significant regression lines are included ($P < 0.1$)

line (all P between 0.1689 and 0.6120; Table I; Figure 2, right panels). Sample sizes for the regressions were low (4–6 points), resulting in low statistical power.

Results of linear regression of mean TL for age 0 stream fish in the fall against spring–summer discharge patterns varied by species (Table II; Figure 3). The mean TL of age 0

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Table II. Linear regression equations for mean TL of age 0 stream fish and Apalachicola River discharge (proportion of days during 1 March–30 September when mean daily discharge ≥ 460 $m^3 \cdot s^{-1}$) with R^2, p and n

Species	Regression Equation	R^2	P	n
Largemouth bass	TL = 36.014 × Discharge + 91.908	0.53	0.042	8
Redear sunfish	TL = 13.639 × Discharge + 61.384	0.07	0.603	6
Spotted sucker	TL = −2.914 × Discharge + 98.321	0.01	0.837	6

largemouth bass was positively and significantly ($P = 0.042$) related to spring–summer discharge, whereas linear regression of age 0 redear sunfish and spotted sucker with spring–summer discharge showed no relationship (both $P \geq 0.603$; Table II; Figure 3).

DISCUSSION

We found positive relationships between age 0 stream fish catch in fall and spring–summer discharge measures in the Apalachicola River, Florida. Other studies have reported similar relationships between strong year-classes of fish and elevated water levels or streamflows for multiple riverine or river influenced habitats, including estuaries (Staunton-Smith *et al*., 2004), reservoirs (Maceina and Stimpert, 1998; DiCenzo and Duval, 2002; Maceina, 2003), rivers (Bonvechio and Allen, 2004; Smith *et al*., 2005) and large river floodplain systems (Raibley *et al*., 1997; Janac *et al*., 2010). Furthermore, the interconnection of fish recruitment, streamflow and floodplain inundation is consonant with previous fish community research at Apalachicola River. Walsh *et al*. (2009) showed extensive use of floodplain habitat by larval stream fish during spring and summer, and Pine *et al*. (2006) and Burgess *et al*. (2012) reported high use of inundated floodplain habitat by telemetered adult stream fish during the spring spawning season that was coincident with the collection of high numbers of larval fishes representing numerous species ($n = 45$) among light trap catch in the floodplain. Combined, these results provide strong implication that floodplain connection and inundation are important for stream fish communities at Apalachicola River, Florida.

River floodplain connection and inundation provides critical exchange of energy and nutrients between river main stem and floodplain ecosystems (Junk *et al*., 1989). Bolstered production in inundated floodplain habitats provides abundant food sources for young-of-the-year stream fishes (Bayley, 1988; Junk *et al*., 1989), and inundated floodplain vegetation creates complex structural habitat, providing refuge from predation (Savino and Stein, 1982; Rozas and Odum, 1988). Therefore, increases in the spatial and temporal breadth of floodplain inundation, as mediated by river discharge, likely explain stream fish recruitment and streamflow relationships.

Size-selective mortality can be very influential on juvenile fish cohorts (Miller *et al*., 1988; Sogard, 1997). Generally, the largest individuals within a cohort enjoy the greatest chances of recruiting to adult populations, as larger body size usually translates into decreased vulnerability to starvation, predation or environmental extremes (Sogard, 1997). Previous research has downplayed the role of size-selective overwinter survival on cohorts of juvenile fishes in Florida (Rogers and Allen, 2009). However, because our sampling occurred in fall, before any potential effects of size-selective survival associated with winter conditions, we thought it was important to investigate fish size as a response to spring–summer discharge patterns. Our results indicated that years with higher river discharge and sustained floodplain inundation during spring–summer allowed age 0 largemouth bass to grow to a larger size in the fall relative to lower discharge years. However, age 0 redear sunfish and spotted sucker growth did not appear to be influenced by spring–summer discharge patterns. These results show that individuals belonging to the large cohorts of fish produced during years of high discharge during spring–summer have average to larger than average body size in fall. On the basis of body size, we would expect large cohorts produced during high flow years to have similar overwinter survival, or greater for largemouth bass, as during years with lower spring–summer discharge patterns. Thus, large cohorts in fall would be expected to remain large cohorts entering age 1. This was corroborated by the similarity of results between empirical catch and back-calculated abundance for age 0 fishes at the Apalachicola River.

Our use of catch rate as an index of abundance for age 0 fishes requires acknowledgment that multiple factors other than true abundance can affect catch rates. Physical habitat variables (i.e. water temperature, conductivity, clarity, habitat complexity and flow velocity), fish size, fish seasonal behaviour patterns and sampling crew have been shown to affect the fraction of a fish stock caught per unit effort (i.e. catchability; Hardin and Connor, 1992; Hilborn and Walters, 1992; Reynolds, 1996; Bayley and Austen, 2002). Timing of our sampling was standardized to fall (September and October), thus reducing the variable influence of factors such water temperature and fish seasonal behaviour patterns. Typically, streamflows are relatively stable during fall at Apalachicola River (Light *et al*., 1998), and we standardized

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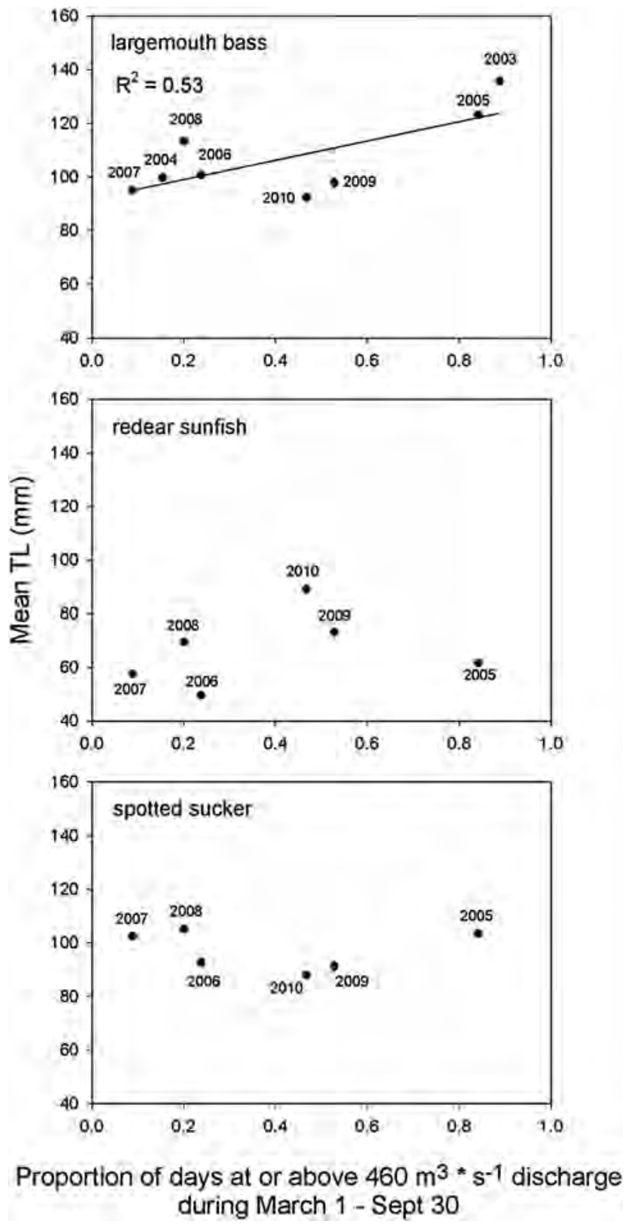

Figure 3. Plots of mean TL of age 0 stream fish in fall against spring–summer river discharge at Apalachicola River, Florida, with linear regression lines. Only significant regression lines are included ($P < 0.1$)

sampling to occur only during discharges where flows were largely confined within the banks of the main stem and major distributary channels. Thus, river stage did not vary substantially across years or during sampling periods, minimizing its influence on our catch rates. Also, our use of back-calculated age 0 catch rates based on cohort-specific catch curves relied on the catch of a cohort over multiple years of sampling and therefore reduced the influence of year to year variation in environmental conditions on fish catchability (Tetzlaff *et al*., 2011). For cohorts that allowed our use of empirical catch and back-calculated catch as indices of recruit abundance, our results were similar, indicating that fluctuations in our catch reflected actual fluctuations in fish abundance and not annual fluctuations in catchability.

The flow metric we used was the proportion of days during spring–summer (1 March–30 September) with river discharge $\geq 460\,m^3{\cdot}s^{-1}$($16{,}400\,ft^3{\cdot}s^{-1}$), but our results were robust to other flow measures. The value of $460\,m^3{\cdot}s^{-1}$ was the median river discharge at Apalachicola River during 1922–1995 as reported by Light *et al*. (1998), and above this discharge threshold, the wetted area of inundated floodplain increases substantially (Light *et al*., 1998). However, we explored alternate flow levels (e.g. 364–$1{,}700\,m^3{\cdot}s^{-1}$) within the 1 March–30 September time frame without seeing substantial changes in our results. In contrast, we explored the use of flow metrics from smaller time frames (e.g. March–May instead of March–September), and shorter time frames resulted in poorer fit of linear models. Therefore, river flows that inundate the Apalachicola River floodplain during spring spawning and maintain portions of inundated floodplain during summer for nursery habitat appear to have the strongest relationship with high stream fish recruitment.

Our results have implications for water management and allocation in the ACF basin. We found clear linkages between flows of the Apalachicola River and recruitment of fish in the system, and water management operations and upstream consumptive uses that substantially reduce the number of days with flow exceeding $460\,m^3{\cdot}s^{-1}$ ($16{,}400\,ft^3{\cdot}s^{-1}$) would be expected to reduce fish recruitment. These findings are important and critical to water management within the ACF basin as Light *et al*. (2006) identified recent downward trends in streamflow at Apalachicola River. We observed fish recruitment response to streamflow across multiple trophic levels within the fish community; therefore, effects of reduced flow likely would be widespread within the Apalachicola River fish community. These biological effects should be considered for streamflow management and water allocation within the basin. Our results indicate that fish monitoring programs that measure both fish CPUE and age composition data can be useful for evaluating management of flow in regulated river systems. Considering the decreasing trend in river flows and the high demand for water use within the basin, continued monitoring of stream fish assemblages at Apalachicola River is recommended.

ACKNOWLEDGEMENTS

Partial funding for this research was provided by the Aquatic Habitat Restoration and Enhancement Subsection of the Habitat and Species Conservation Division of the Florida Fish and Wildlife Conservation Commission.

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DOI: 10.1002/rra

Received: 5 March 2018 | Revised: 5 July 2018 | Accepted: 6 July 2018
DOI: 10.1002/rra.3333

RESEARCH ARTICLE

WILEY

Effects of hydropeaking operations on the growth of Alabama bass *Micropterus henshalli* and redeye bass *Micropterus coosae* in the Tallapoosa River, Alabama, USA

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Funding information
Alabama Department of Conservation and Natural Resources, Grant/Award Number: F11AF00570 (AL F-40-40) Study 60

Abstract

Anthropogenic factors such as dam construction and hydropower generation can dramatically alter the flow regime of rivers and may impact growth of aquatic organisms. Using incremental growth techniques, annual growth of Alabama bass *Micropterus henshalli* and redeye bass *M. coosae* in the Tallapoosa River, Alabama, USA, was evaluated in response to variation in flow regime. Fish were collected from the Tallapoosa River above Harris Dam (unregulated site) and at two sites downstream of the dam (regulated sites), as well as Hillabee Creek (unregulated tributary). Flow variables were calculated for each growth year, and the best model that described growth for each species at each location was determined using Akaike's Information Criterion. Additionally, growth increments of each species at ages 1, 2, and 3 were compared between years characterized by low and high flow variability. Age was the best explanatory variable that described growth in all models, although flow variables were included in more than half the models. In all cases, annual and seasonal flow variables had low predictive power and explained <2% of the variation in growth. Growth was higher for age-1 fish in years with less flow variation but was similar among years for age-2 and age-3 fish. Overall, this study provided little evidence that annual growth of either species was heavily influenced by flow in this regulated river.

KEYWORDS

Alabama bass, growth, hydropeaking, redeye bass, Tallapoosa River

1 | INTRODUCTION

Hydroelectric dams alter the natural flow regime of rivers, especially when these dams are operated in peaking mode. Widely fluctuating flows result in less stable habitats due to changes in water depth and wetted area, increased bank incision, sedimentation, and water turbidity, all of which can affect food quality and quantity for predacious fishes (Arndt, Cunjak, & Benfey, 2002; Bond, Jones, & Haxton, 2016; Lobon-Cervia, 2004). Yet few studies have evaluated growth of adult fishes in context of flow regimes, whether natural or non-natural. A majority of the studies examining the effects of flow on fish growth have focused on larval and juvenile life stages (e.g., Finch, Pine, & Limburg, 2015; Korman & Campana, 2009). These studies provided some evidence that growth can be influenced by river hydrology, but did not consider fish growth over the entire lifespan (but see Bond et al., 2016).

A flow regime can be broken into five ecological aspects: magnitude, frequency, duration, timing, and rate of change or flashiness (Poff & Ward, 1989). These components can help define the type of river system and how certain anthropogenic factors affect it, and for this study, we used the definitions offered by Poff et al. (1997) for each aspect. Magnitude is the amount of water that passes a fixed location, analysed by looking at a minimum, maximum, and mean flow. Frequency is the number of times a specified magnitude is reached. Duration is the amount of time associated with a specified flow, usually expressed relative to a certain event or over time. Timing refers to the regularity in which a certain magnitude occurs. Lastly, flashiness is how quickly a flow changes from one magnitude to another. All these flow measures vary seasonally, which can provide important cues to the aquatic organisms within the systems.

Incremental growth analysis has been widely used in various fields, including marine fisheries, but is less commonly used in freshwater, possibly due to the shorter lifespan of freshwater fishes (Rypel, 2009). Quist and Guy (2001) used this technique to assess the effects of habitat and community characteristics on growth of several prairie stream fishes in Kansas. Other studies demonstrated that growth of freshwater fishes was related to both flow and climate variables (e.g., Rypel, 2009; Sammons & Maceina, 2009), but how altered flow regimes from hydropeaking operations impact growth of adult fishes has been little studied.

This study examined growth of two black bass, redeye bass *Micropterus coosae* and Alabama bass *Micropterus henshalli* (Table 1), in relation to hydropeaking flows. Redeye bass are an obligate lotic species native to the Mobile Basin (Leitner & Earley, 2015). These fish are usually found above the fall line, a geologic feature that separates the Coastal Plain Physiographic Province from upland provinces. They are typically found in small to medium sized upland streams, rarely in large rivers. Alabama bass are also native to the Mobile Basin; however, they are widely distributed throughout the system in both lentic and lotic habitats (Rider & Maceina, 2015). This study was conducted in the Tallapoosa River in east-central Alabama, USA, below the upstream-most hydropeaking facility in the system. The river has been extensively impounded for flood control, downstream navigation, hydropower, and water supply. Previous research on the Tallapoosa River has examined fish community responses to the altered flow regime (e.g., Freeman, Bowen, Bovee, & Irwin, 2001; Kinsolving & Bain, 1993; Travnichek, Bain, & Maceina, 1995), but there has been minimal work on sportfish, especially the black bass found within the river system. Redeye bass and Alabama bass are important native sportfish in the Tallapoosa River, and understanding how they are affected by the current flow regime will aid in future management of the fishery. Thus, the objective of this study was to evaluate annual growth of these two species in response to hydropeaking operations on this river.

2 | STUDY SITE

Originating in north-western Georgia, the Tallapoosa River flows 421 km south-westerly across east-central Alabama to its confluence with the Coosa River, forming the Alabama River. The focal area of this research was the 79-km reach of river downstream of Harris Dam to the headwaters of Martin Reservoir (Lake Martin). This reach is characterized by a physically stable channel, with low-gradient habitats and silt substrate as well as high-gradient shoal habitats dominated by bedrock and boulders. Tributaries to the Tallapoosa River within this reach exhibit similar habitat and are dominated by bedrock and boulders, but the Tallapoosa River upstream of Harris Dam is dominated by sandy substrate with occasional rocky outcrops.

Flow is highly regulated by Harris Dam, which normally is operated in hydropeaking mode, where water is released in pulses for 4–6 hr through one or two turbines (capacity of 226 m^3/sec); power generation can occur once or twice a day, which results in extreme fluctuation in flow and stage, especially in the first 20 km downstream of the dam, creating highly variable habitats (Irwin & Freeman, 2002). The dam releases hypolimnetic water and temperatures can fluctuate up to 10°C with the flow variation, with higher temperature fluctuations in areas closer to the dam (Irwin & Freeman, 2002). Although adaptive management procedures are currently underway to moderate flows, there are no regulations on the magnitude or the duration of water releases.

The fish community in the Tallapoosa River is quite diverse, once harbouring 126 species, although loss of habitat and flow alterations resulting from impoundment have reduced the native fish fauna (Freeman, Irwin, Burkhead, Freeman, & Bart Jr, 2005). Primary sport fishes in the river are Alabama bass, redeye bass, largemouth bass *Micropterus salmoides*, and redbreast sunfish *Lepomis auritus*. A related study of the two regulated areas using electrofishing found that relative abundance of Alabama bass and redeye bass ranged from 9.5 to 33.6 and 0 to 2.2 fish/hr, respectively, across seasons, years, and areas (Sammons, Earley, & McKee, 2013). The upper regulated site was characterized by fewer, but larger, individuals of both species compared with the lower site. Age-0 densities were noticeably lower

TABLE 1 Species summary for the Alabama bass *Micropterus henshalli* and redeye bass *Micropterus coosae* as described in Rider and Maceina (2015) and Leitner and Earley (2015)

	Alabama bass *Micropterus henshalli*	Redeye bass *Micropterus coosae*
Range	Native: Mobile River Basin Introduced: California, Georgia, North Carolina, South Carolina, Tennessee, and Texas	Native: Alabama, Georgia, western South Carolina, North Carolina, and Tennessee Introduced: Northern Tennessee, Kentucky, West Virginia, Arkansas, California, and Puerto Rico
Habitat	Habitat generalist. Found in reservoirs and medium to large rivers. Found in clear and deep reservoirs, turbid waters with sand or mud substrates, and brackish waters.	Habitat specialist. Found in cool flowing Piedmont streams and rivers, with moderate current and rocky substrates. Can be found in mountain and Piedmont reservoirs.
Population dynamics	Maximum age: 13–14 years Growth rates: Comparable with largemouth bass *Micropterus salmoides*. Higher growth found in reservoirs compared with lotic systems.	Maximum age: 9–10 years Growth rates: Slower growth compared with other black bass species. Higher growth rates when found in reservoirs.
Mean home range	81.39 ha (range: 3.05–249.44 ha)	85.63 ha (range: 14.42–231.77 ha)
Migratory distance in the Tallapoosa River	9–20 km	8–20 km

Note. Migratory distance in the Tallapoosa River was taken from a related study (Earley & Sammons, 2015).

at the upper regulated site for both species, and efforts to collect as little as 50 individuals from this area for hatch-date analysis were unsuccessful (Sammons et al., 2013).

3 | METHODS

Fish were collected from 2009 to 2011, with a target of 50 redeye bass and 100 Alabama bass from each of three locations on the Tallapoosa River: Horseshoe Bend-Germany's Ferry (lower site), Wadley-Price Island (middle site), and the unregulated upper Tallapoosa (upper site) above Harris Dam (Figure 1). Due to difficulties in collecting redeye bass from the upper Tallapoosa River, additional fish were collected from Hillabee Creek, an unregulated fourth-order tributary of the Tallapoosa River (Figure 1). The two regulated sites were chosen to allow examination of the effects of flow variation on age and growth across a gradient of flow variability, as flow regime variability lessens as distance below the dam increases (Figure 2). These two sites were separated by more than 32 km, far more than the maximum movement distance found for Alabama bass and redeye bass by Earley and Sammons (2015), listed in Table 1. Thus, we considered these two areas independent with regards to this study. Fish were collected from all Tallapoosa River sites using a boom-mounted electrofishing boat; sampling occurred at the middle and lower sites in October 2009 and May, August, and October 2010 and 2011 and at the upper site in March and April 2011. In each area, sampling was conducted over a 2 to 4-km reach, and attempts were made to sample all representative shoreline and shoal habitats available within each reach. Redeye bass were collected from the Hillabee Creek site using hook and line sampling in July 2011. In the laboratory, fish were measured for total length (mm) and weighed (g), and saggital otoliths were extracted and placed in vials.

Otoliths were broken through the nucleus and mounted onto slides using thermoplastic cement and then ground until a thin section was obtained (Maceina, 1988). Otoliths were examined under an image-analysis system and were measured from the focus to the outer edge; each annuli were measured similarly, and the total length at each annulus was calculated using the direct proportion method (DeVries & Frie, 1996). Length-frequencies of the back-calculated ages were compared with the observed length frequencies at each age to verify that back-calculated lengths were similar to actual lengths (Sammons & Maceina, 2009). Growth increments for each growth year were considered to be the difference between back-calculated lengths in successive ages. The start and end of a

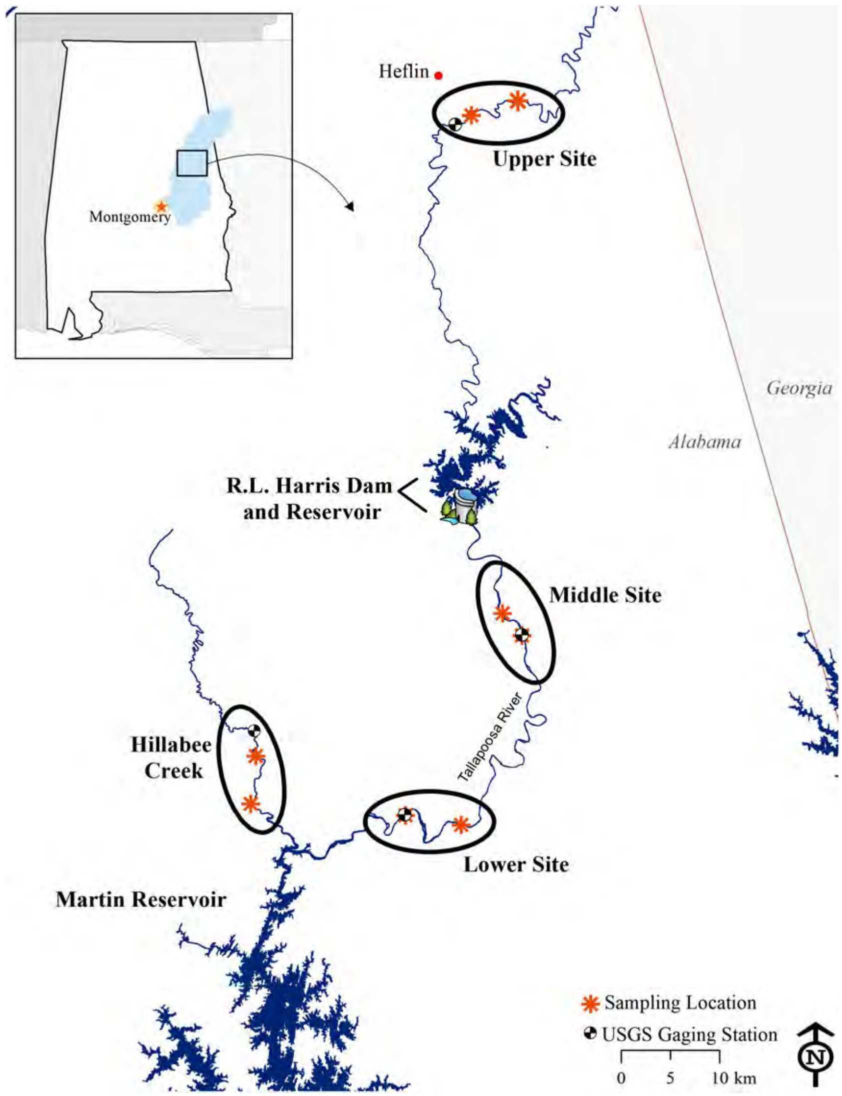

FIGURE 1 Map depicting the sampling locations (orange asterisks) and the U.S. Geological Survey gaging stations in the Tallapoosa River watershed, Alabama [Colour figure can be viewed at wileyonlinelibrary.com]

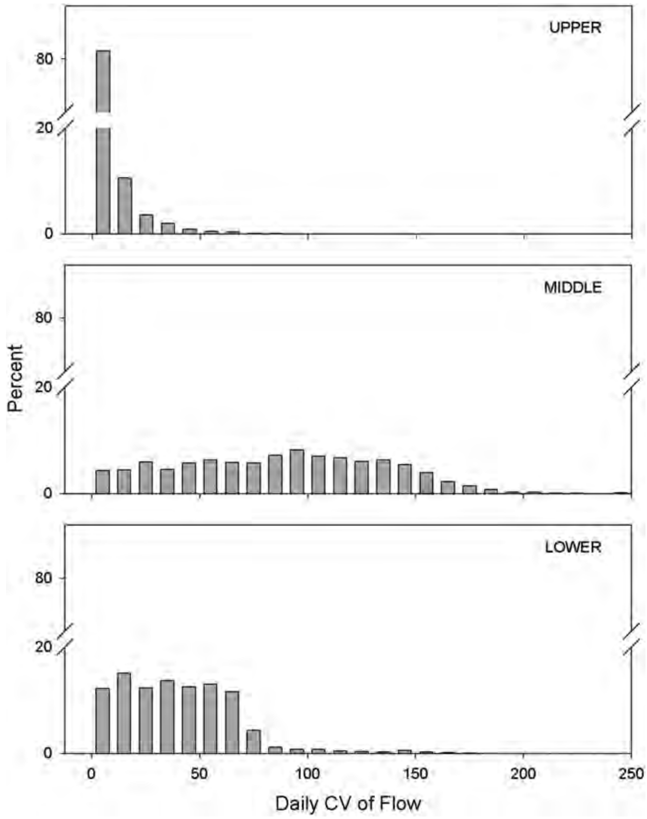

FIGURE 2 Distribution of 24-h coefficients of variation (CV) of discharge measured every 30 min from 1998 to 2010 at three U.S. Geological Survey gaging stations located near sampling sites used in this study on the Tallapoosa River

TABLE 2 Hydrologic variables used to explain annual growth of Alabama bass and redeye bass from three sites on the Tallapoosa River and one on Hillabee Creek

Site	Variable	Definition
Upper site	Above	Days river discharge was ≥Q5 (44.43 m^3/s)
	Below	Days river discharge was ≤Q95 (0.74 m^3/s)
	Flashiness	Richard-Bakers Index (0–1)
	Median	Median discharge (m^3/s)
	Peaks	Frequency of peaks greater than 6 m^3/s
	Variance	Variation in 30 min discharge
Middle site	Above	Days river discharge was ≥Q5 (217.47 m^3/s)
	Peaks	Frequency of peaks greater than 14.2 m^3/s
	Variance	Variation in 30 min discharge
Lower site	Above	Days river discharge was ≥Q5 (253.33 m^3/s)
	Below	Days river discharge was ≤Q95 (7.59 m^3/s)
	Flashiness	Richard-Bakers Index (0–1)
	Median	Median discharge (m^3/s)
	Peaks	Frequency of peaks greater than 28.3 m^3/s
	Variance	Variation in 30 min discharge
Hillabee Creek	Above	Days river discharge was ≥Q5 (22.93 m^3/s)
	Below	Days river discharge was ≤Q95 (0.39 m^3/s)
	Flashiness	Richard-Bakers Index (0–1)
	Median	Median discharge (m^3/s)
	Peaks	Frequency of peaks greater than 4 m^3/s
	Variance	Variation in 30 min discharge

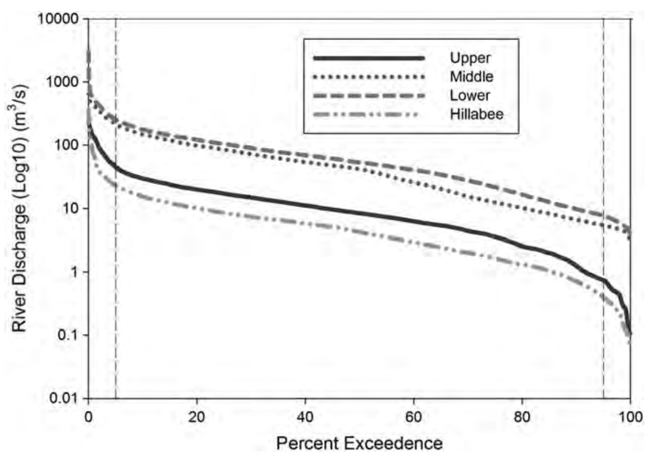

FIGURE 3 Flow duration curves based on mean daily discharges (m^3/s) from water years 2000–2010 for three Tallapoosa River sites and the Hillabee Creek site. The vertical dotted lines represent the Q5 and Q95, where flow will exceed these points 5% or 95% of the time

growth year was based on the timing of annuli formation following Sammons and Maceina (2009), based on observations of otoliths collected during the summer, which was defined for both species as July 1 to June 30.

River discharge data were obtained from four U.S. Geological Survey (USGS) gaging stations that were located in close proximity to the sampling locations (Figure 1). All gages recorded data every 30 min. Variables describing five ecological aspects of the Tallapoosa River flow regime were calculated for each site to describe the flow regime characteristics (Table 2). The annual median discharge was calculated to evaluate magnitude, and peaking flows were tallied for each growth year to evaluate frequency (based on Sakaris, 2006). Duration was calculated by summing the number of days flow was above and below high and low flow periods, selected from a flow duration curve generated using mean daily discharge for water years 2000–2010 at each station (Figure 3). High flows were defined by the Q5, where flows exceeded this point 5% of the time and low flows were defined by Q95, where flows exceeded this point 95% of the time. Flashiness was evaluated by calculating the Richards-Baker Flashiness Index (Baker, Richards, Loftus, & Kramer, 2004), which ranges from 0 to 1, with 0 representing a stable habitat and 1 being extremely flashy. Additionally, the rate of flow change was described using the variance of instantaneous discharge measured by the USGS gages. To assess seasonal importance of flows on fish growth, growth years were divided into summer (July–September), fall (October–December), winter (January–March), and spring (April–June) following Sammons and Maceina (2009).

Relations between river flow variables and length increments were examined with a multiple regression analysis (Maceina, 1992), using a general regression model:

$$L_{inc} = b_0 – b_1(AGE) + b_i(FLOW);$$

where b_0, b_1, and b_i are the regression coefficients for the intercept and slope coefficients, and FLOW is one or more flow variables based on season, growth year, and a combination of season and growth year. For each site, candidate models were chosen based on Akaike's Information Criteria, and the best model among these was chosen using the Variance Inflation and Condition indices (Burnham & Anderson, 2002; SAS Institute Inc., 2004). Semipartial correlation coefficients (SCORR1) and the squared partial correlation coefficients (PCORR2) were calculated to determine the amount of variation explained by each variable in the best model. To further assess the impacts of flow variability on growth, a year with high flow variation (50% of the recorded flows were above mean annual variation calculated using water years 2000–2010 data) and a year with low flow variability (50% of recorded flows were below mean) were selected. Growth increments for age 1–3 fish of both species were compared between low and high flow variability years using student's *t*-tests at each sampling location (Table 3).

An analysis of covariance (ANCOVA) was used to evaluate differences in growth among sites for each species. Because the timing of fish sampling occurred from April to October, ages were corrected to account for growth past the last annulus based on season by adding 0.083 (1/12) for every month beyond the end of the previous growth year (i.e., past June 30) that the fish were collected (Sammons & Macenia, 2009). Ages were log transformed for all analyses. Independent variables in the ANCOVA were age and site, with length at age as the dependent variable. The ANCOVAs tested for differences in the slopes between length at age and age among sites for each species (Pope & Kruse, 2007). If slopes were similar, another ANCOVA was used to assess differences in the adjusted mean length of each species among sites. The ANCOVAs were run for age 1–7 Alabama bass and 1–5 redeye bass to minimize biases associated with low sample size of older fish. Significance was set at $\alpha = 0.05$ for all tests.

4 | RESULTS

Overall, 361 Alabama bass and 170 redeye bass were collected from sites on the Tallapoosa River. Of these 531 otoliths, 516 were readable. Readable otoliths were obtained from 69 Alabama bass and 18 redeye bass at the upper site, 147 Alabama bass and 63 redeye bass from the middle site, and 133 Alabama bass and 50 redeye bass from the lower site. An additional 36 redeye bass were collected from Hillabee Creek, 34 of which were readable.

TABLE 3 Minimum, maximum, mean and variance in the 30-min flow data (m^3/s) from the growth years that represent high and low flow variability at the four sampling locations

	Upper	Middle	Lower	Hillabee
High variability				
Min flow	1.72	3.08	4.41*	0.80
Max flow	230.90	725.92	687.99*	298.78
Mean flow	27.23	125.50	113.21*	15.33
Variance	1201.18	20994.99	11510.95*	777.86
Low variability				
Min flow	0.11	1.69	2.98	0.05
Max flow	95.45	432.10	450.25	96.67
Mean flow	6.02	27.09	31.96	3.14
Variance	85.32	3292.72	2429.44	32.79

Note. The asterisks denote data that was collected in growth year 2004; otherwise, the year of high variability was 2009 and low variability was 2007.

All candidate models explaining growth of Alabama Bass contained flow variables along with age at each site; however, Akaike weights were <0.02 for all models at the upper and lower sites, which is very low (Table 4). In contrast, Akaike weights for candidate models were more than fivefold higher at the middle site. Most candidate models explaining growth of redeye bass also contained flow variables at all sites; however, the best model contained only age as an explanatory variable at both the upper and lower sites (Table 5). Similar to Alabama bass, Akaike weights of models were highest at the middle site, but in general, all Akaike weights were higher for redeye bass models than Alabama bass models.

As expected, growth was inversely related to age in all cases; age accounted for 60–65% of the variation in the Alabama bass models and 68–71% of the variation in the redeye bass models (Table 6). Due to high Variance Inflation Factor, the below variable was removed for Alabama bass at the lower site and variance and above variables were removed from the redeye bass at the middle site. Overall, no model had an environmental parameter that explained more than an additional 2% of the variation in the data (Table 6). All but one of the best models explaining Alabama bass growth included environmental variables, whereas half of the best models explaining redeye bass growth included environmental variables (Table 6).

TABLE 4 Top five candidate models produced from the all model subset analysis for Alabama bass growth and river hydrologic variables at each sampling location for the entire growth year and season

Model	K_i	AIC_c	Δ_i	w_i
Upper				
Age peaks	4	1922.94	0.00	0.0185
Age below peaks	5	1923.57	0.63	0.0135
Age flashiness peaks	5	1924.46	1.53	0.0086
Age peaks spring	5	1924.64	1.71	0.0079
Age peaks winter	5	1924.65	1.82	0.0079
Middle				
Age above peaks variance spring	7	5692.98	0.00	0.1173
Age above peaks summer fall winter spring	9	5693.53	0.54	0.0894
Age above peaks variance summer fall winter	9	5693.75	0.76	0.0801
Age above peaks variance fall spring	8	5693.85	0.86	0.0760
Age above peaks variance summer spring	8	5693.80	1.82	0.0472
Lower				
Age fall winter	5	4120.04	0.00	0.0198
Age peaks fall	5	4120.36	0.32	0.0168
Age peaks fall winter	6	4120.41	0.37	0.0164
Age variance fall	5	4120.74	0.71	0.0139
Age variance fall winter	6	4120.75	0.71	0.0139

Note. The model with the lowest Akaike's Information Criteria (AIC_c) score was considered the best model among the candidate models. Below, median, and flashiness are not included in the middle site global model due to collinearity.

TABLE 5 Top five candidate models produced from the all model subset analysis for redeye bass growth and river hydrologic variables at each sampling location for the entire growth year and season

Model	K_i	AIC_c	Δ_i	w_i
Upper				
Age	3	431.42	0.00	0.0494
Age flashiness	4	432.87	1.46	0.0228
Age summer	4	433.22	1.80	0.0200
Age spring	4	433.63	2.21	0.0163
Age below	4	433.71	2.34	0.0156
Middle				
Age peaks winter spring	6	1291.16	0.00	0.1402
Age peaks winter	5	1291.88	0.72	0.0980
Age peaks fall	5	1292.04	0.88	0.0902
Age peaks summer	5	1292.10	0.93	0.0878
Age peaks fall spring	6	1292.19	1.03	0.0838
Lower				
Age	3	999.93	0.00	0.0370
Age summer	4	1001.13	1.20	0.0204
Age variance spring	5	1001.61	1.68	0.0160
Age spring	4	1001.62	1.69	0.0159
Age fall	4	1001.80	1.87	0.0146
Hillabee				
Age fall	4	769.04	0.00	0.0183
Age spring	4	769.31	0.27	0.0160
Age variance	4	769.60	0.57	0.0138
Age winter	4	769.99	0.95	0.0114
Age above fall	5	770.42	1.38	0.0092

Note. The model with the lowest Akaike's Information Criteria (AIC_c) score was considered the best model among the candidate models. Below, median, and flashiness are not included in the middle site global model due to collinearity.

There was a noticeable trend (six of eight comparisons) for Alabama bass to have slightly higher annual growth in a low flow variability year; however, this difference was only significant for age-1 fish at the upper site (Figure 4; t = 2.94; df = 25; P = 0.0069) and age-3 fish at the middle site (t = 2.74; df = 28; P = 0.0107). Conversely, growth appeared faster in the high flow variation year for age-1 Alabama bass at the middle site and age-2 Alabama bass at the lower site. However, the difference at the middle site was not significant (t = 0.65; df = 27; P = 0.5209), and the lower site had only one observation of growth during the high variation year. Mean growth increments of age-1 redeye bass were greater in the low flow variability year than the high flow variation year at all three sites on the Tallapoosa River (Figure 4; $|t| \geq 2.26$; $df \geq 5$; $P \leq 0.0262$). Additionally, growth of age-2 redeye bass at the middle site was also faster in the low flow variability year (t = 2.47; df = 10; P = 0.0333). Growth increments were similar between years for the five other age and site combinations (Figure 4).

Growth of Alabama bass was faster in the middle area than in the other two areas (F = 8.66; df = 2, 698; P = 0.0002). Similar to Alabama bass, growth of redeye bass was highest in the middle site than in the upper or the lower site (F = 8.50; df = 2, 103; P = 0.0004).

5 | DISCUSSION

Results of this study indicated that the metrics used to describe the hydrologic regime of the Tallapoosa River had only a minor effect on the growth of Alabama bass and redeye bass over their life cycle. Typical for these analyses, age was the best predictor variable for explaining the variation in growth in all models (Maceina, 1992; Sammons & Maceina, 2009; Stocks, Stewart, & Gray, 2011), as growth of fishes typically begins to slow down upon reaching sexual maturity, eventually reaching an asymptote. However, flow variables were included in more than half the models, suggesting that the hydrologic regime did have some influence on growth of these species.

Three models predicted that growth declined as frequency of flow peaks increased. Similarly, Sakaris (2006) found that growth of age-0 fish of two catfish species decreased as frequency of peaks increased

TABLE 6 Overall best models explaining the relation of growth to annual and seasonal flow variables for Alabama bass and redeye bass at each of the sampling locations

Location	Species	Variable	Relationship	PCORR	SCORR	P value	r^2
Upper	Alabama bass	Age	–	0.6294	0.6310	<0.0001	0.6.469
		Peaks	–	0.0175	0.0473	0.0016	
	Redeye bass	Age	–			<0.0001	0.7136
Middle	Alabama bass	Age	–	0.6517	0.6354	<0.0001	0.6592
		Above	–	0.0000	0.0025	0.2144	
		Peaks	–	0.0006	0.0044	0.0983	
		Variance	+	0.0019	0.0066	0.0439	
		Summer	–	0.0022	0.0063	0.0489	
	Redeye bass	Age	–	0.7145	0.7003	<0.0001	0.7434
		Peak	–	0.0031	0.0331	0.0268	
		Winter	+	0.0073	0.0189	0.0954	
		Spring	–	0.0186	0.0677	0.0014	
Lower	Alabama bass	Age	–	0.5976	0.5901	<0.0001	0.6096
		Fall	+	0.0062	0.0062	0.0985	
		Winter	–	0.0082	0.0211	0.0082	
	Redeye bass	Age	–			<0.0001	0.6418
Hillabee	Redeye bass	Age	–	0.6842	0.6985	<0.0001	0.7033
		Fall	–	0.0191	0.0604	0.0226	

Note. The relationship between the variable and growth (+ denotes positive and – denotes negative), the squared partial regression coefficients (PCORR), the semipartial regression coefficients (SCORR), and P values for the model variables are included.

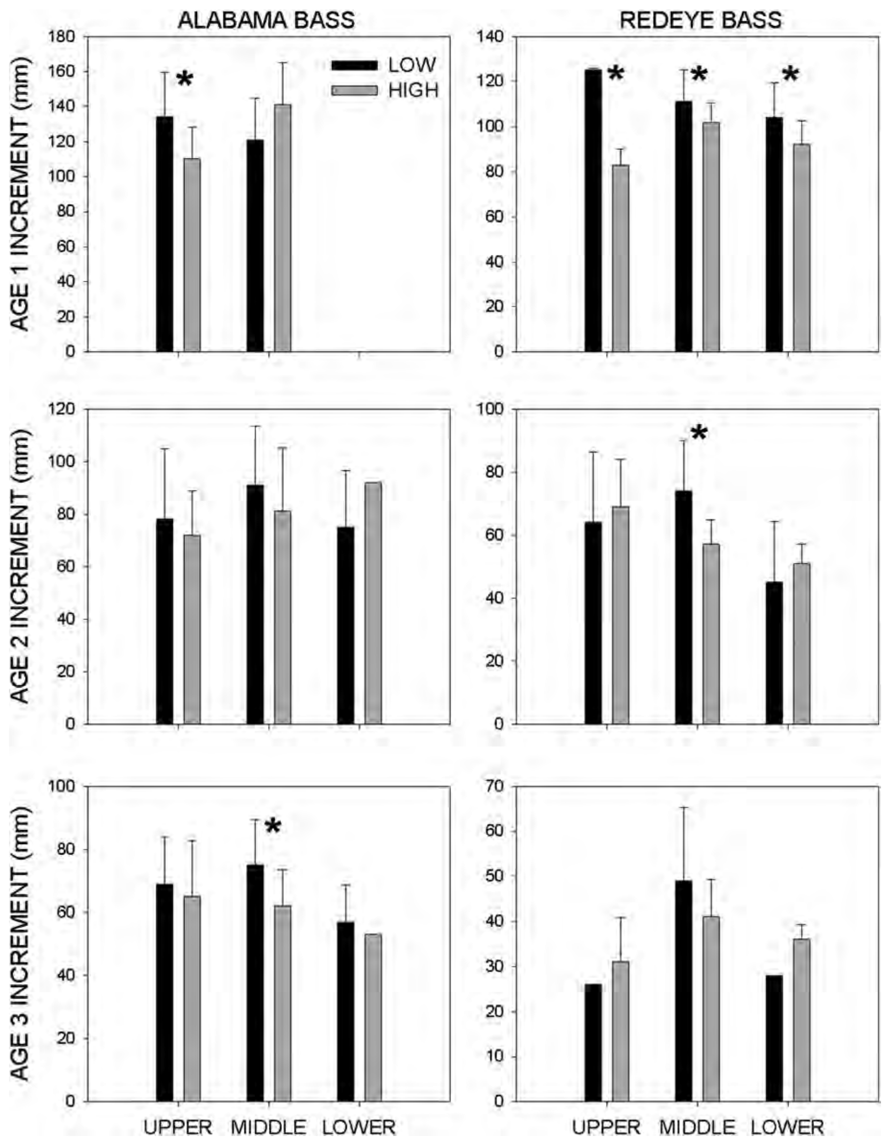

FIGURE 4 Mean growth increments for Alabama bass and redeye bass in a year with high flow variability and a year with low flow variability. Asterisks denote significantly different comparisons ($P \leq 0.05$)

in the Tallapoosa River. Our study suggested that Alabama bass growth was negatively influenced by peak flows at the unregulated site. Additionally, growth of both species was impacted by flow variability at the middle site, which experienced the most dramatic flow variations due to the dam operation. This was not the case at the lower site, where hydropeaking flow fluctuations become attenuated due to increased channel width and distance from Harris Dam.

The remaining models for both Alabama bass and redeye bass included both annual and seasonal predictors; 57% of the best models included a seasonal variable, indicating that seasonal flow may have some influence on the growth of these fish, especially in fall or winter. Higher growth of these species was sometimes associated with higher flow variation in these seasons. Typically, flows in the Tallapoosa River are lowest during the summer and fall (USGS, unpublished data). Earley and Sammons (2015) suggested that based on movement patterns of these fishes, the increased discharge when flows are normally low may allow for better foraging conditions due to increased food availability, which has also been observed in other studies (Beckett & Miller, 1982; Gore, 1977). More commonly, models in our study predicted that growth of both species was negatively impacted by increased flows or flow variation. However, it must be stated that all flow variables included in our models had low predictive power and Akaike weights and explained less than 2% of the variation in the data after accounting for age. Thus, none of the models were conclusive in establishing how the flow regime impacted growth. It is possible that the true impacts of the hydrologic regime were not best defined by the variables chosen to examine growth.

Our empirical results generally suggested that growth of age-1 fish of both species was greater in years with less flow variability. Years of low variability are usually characterized by low discharge, which can increase the stability of stream environments (Poff & Allan, 1995). This may allow for easier access to food and more efficient predation, resulting in greater growth. Schlosser (1985) found that juvenile abundances of sunfish and minnows increased in Illinois streams with low flow conditions, all of which were likely important diet items for both bass species in this study (Leitner & Earley, 2015; Rider & Maceina, 2015). Alternatively, low flow variability and discharge could have increased primary productivity in the Tallapoosa

River during those years, leading to higher growth in younger fishes (Power & Stewart, 1987; Schlosser, 1982). There appeared to be less effect of hydrology on growth of older fish in the Tallapoosa River, which may have contributed to the low predictive power of our regression models.

Spawning success and recruitment of fishes have been found to be inversely related to magnitude and variability of discharge (Freeman et al., 2001; Mallen-Cooper & Stuart, 2003; Sammons, Ingram, & Kilpatrick, in press; Smith, Odenkirk, & Reeser, 2005). Further, a longitudinal gradient in numbers of age-0 black bass was observed in our regulated reach of the Tallapoosa River during a concomitant study (Sammons et al., 2013). Relative abundance of age-0 fish was considerably lower at the middle site compared with the lower site. The fastest growth rates of both black bass species found in our study occurred at the middle site, corresponding to the site with the lowest recruitment. Thus, recruitment of these black bass species in the Tallapoosa River may be lower during high-flow years, especially at the middle site, which could result in a density dependent growth (Matthews, Gido, & Marsh-Matthews, 2001; Shelton, Smitherman, & Jensen, 1981).

Harris Dam releases hypolimnetic water, and temperatures can fluctuate up to 10°C with the flow variation, with higher temperature fluctuations in areas closer to the dam (Irwin & Freeman, 2002). Temperature can impact growth of fishes (Deegan, Golden, Harvey, & Peterson, 1999; Hickman & Hevel, 1986; Imsland, Sunde, Folkvord, & Stefansson, 1996), and cold hypolimnetic releases can be detrimental to native warmwater species, especially at early life stages (Clarkson, Childs, & Schaefer, 2000). Temperature fluctuations over a 24-h period at our middle site (where they would be expected to be highest) were <5°C 83% of the time between 2005 and 2010 (Alabama Power Company, unpublished data). Temperature preferences of Alabama bass and redeye bass are unknown, but temperature changes of this relatively small magnitude are unlikely to significantly affect growth of black bass (Rice, Breck, Bartell, & Kitchell, 1983). In order to completely rule out temperature as a dependent variable, more research should be completed on the temperature fluctuations from the hypolimnetic releases and the effects on growth.

Beginning in 2005, pulses of water were released from Harris Dam over a period of time in lieu of releasing water all at once, resulting in lower rises, reduced peaks, and less drastic falls (*sensu* Irwin & Freeman, 2002). These pulses lessened the rise and reduced the peak, and the fall was less drastic. We could not test the hypothesis that this management strategy may have helped lessen the impact on fish growth because we had no otolith samples from fish prior to 2005. Several studies suggested that species that also thrive in lentic environments may not be as heavily impacted by regulated streamflow (Bain, Finn, & Booke, 1988; Poff & Allan, 1995). We expected that Alabama bass would not be greatly impacted by the variation in flow because they are a larger and a habitat generalist compared with redeye bass, a smaller obligate lotic species. However, this study did not provide strong evidence that growth of either species was heavily influenced by flow in this river. Other factors, including density-dependent growth due to lower recruitment resulting from hydropeaking operations, likely have a greater effect on black bass growth than flow variation.

ACKNOWLEDGEMENTS

The authors would like to thank Mike Maceina, Aaron Kern, Christopher McKee, Jonathan Brown, Colin Dinken, and Ryan Lothrop for all the assistance in the field. Dwight Brown and Gene Jenkins provided river access on their property, which was extremely helpful in completing this work. The authors also thank two anonymous reviewers and Dr. Martin Thoms, for their comments and feedback, which greatly helped to improve this manuscript. All work was conducted under the licence from the Auburn University animal care and use permit 2009-1608. We thank Alabama Department of Conservation and Natural Resources for funding this project.

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How to cite this article: Earley LA, Sammons SM. Effects of hydropeaking operations on the growth of Alabama bass *Micropterus henshalli* and redeye bass *Micropterus coosae* in the Tallapoosa River, Alabama, USA. *River Res Applic*. 2018;1–9. https://doi.org/10.1002/rra.3333

D-25

CLAY L. PIERCE

The Flood Pulse Concept in River–Floodplain Systems

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Abstract

JUNK, W. J., P. B. BAYLEY, AND R. E. SPARKS. 1989. The flood pulse concept in river-floodplain systems, p. 110–127. *In* D. P. Dodge [ed.] Proceedings of the International Large River Symposium. Can. Spec. Publ. Fish. Aquat. Sci. 106.

The principal driving force responsible for the existence, productivity, and interactions of the major biota in river–floodplain systems is the flood pulse. A spectrum of geomorphological and hydrological conditions produces flood pulses, which range from unpredictable to predictable and from short to long duration. Short and generally unpredictable pulses occur in low-order streams or heavily modified systems with floodplains that have been leveed and drained by man. Because low-order stream pulses are brief and unpredictable, organisms have limited adaptations for directly utilizing the aquatic/terrestrial transition zone (ATTZ), although aquatic organisms benefit indirectly from transport of resources into the lotic environment. Conversely, a predictable pulse of long duration engenders organismic adaptations and strategies that efficiently utilize attributes of the ATTZ. This pulse is coupled with a dynamic edge effect, which extends a "moving littoral" throughout the ATTZ. The moving littoral prevents prolonged stagnation and allows rapid recycling of organic matter and nutrients, thereby resulting in high productivity. Primary production associated with the ATTZ is much higher than that of permanent water bodies in unmodified systems. Fish yields and production are strongly related to the extent of accessible floodplain, whereas the main river is used as a migration route by most of the fishes.

In temperate regions, light and/or temperature variations may modify the effects of the pulse, and anthropogenic influences on the flood pulse or floodplain frequently limit production. A local floodplain, however, can develop by sedimentation in a river stretch modified by a low head dam. Borders of slowly flowing rivers turn into floodplain habitats, becoming separated from the main channel by levées.

The flood pulse is a "batch" process and is distinct from concepts that emphasize the continuous processes in flowing water environments, such as the river continuum concept. Floodplains are distinct because they do not depend on upstream processing inefficiencies of organic matter, although their nutrient pool is influenced by periodic lateral exchange of water and sediments with the main channel. The pulse concept is distinct because the position of a floodplain within the river network is not a primary determinant of the processes that occur. The pulse concept requires an approach other than the traditional limnological paradigms used in lotic or lentic systems.

river/floodplain/ecosystem theory

Résumé

JUNK, W. J., P. B. BAYLEY, AND R. E. SPARKS. 1989. The flood pulse concept in river-floodplain systems, p. 110–127. *In* D. P. Dodge [ed.] Proceedings of the International Large River Symposium. Can. Spec. Publ. Fish. Aquat. Sci. 106.

Les inondations occasionnées par la crue des eaux dans les systèmes cours d'eau-plaines inondables constituent le principal facteur qui détermine la nature et la productivité du biote dominant de même que les interactions existant entre les organismes biotiques et entre ceux-ci et leur environnement. Ces crues passagères, dont la durée et la prévisibilité sont variables, sont produites par un ensemble de facteurs géomorphologiques et hydrologiques. Les crues de courte durée, généralement imprévisibles, surviennent dans les réseaux hydrographiques peu ramifiées ou dans les réseaux qui ont connu des transformations importantes suite à l'endiguement et au drainage des plaines inondables par l'homme. Comme les crues survenant dans les réseaux hydrographiques d'ordre inférieur sont brèves et imprévisibles, les adaptations des organismes vivants sont limitées en ce qui a trait à l'exploitation des ressources de la zone de transition existant entre le milieu aquatique et le milieu terrestre (ATTZ), bien que les organismes aquatiques profitent indirectement des éléments transportés dans le milieu lotique. Inversement, une crue prévisible de longue durée favorise le développement d'adaptations et de stratégies qui permettent aux organismes d'exploiter efficacement l'ATTZ. Une telle crue s'accompagne d'un effet de bordure dynamique qui fait en sorte que l'ATTZ devient un « littoral mobile ». Dans ces circonstances, il n'y a pas de stagnation prolongée et le recyclage de la matière organique et des substances nutritives se fait rapidement, ce qui donne lieu à une productivité élevée. La production primaire dans l'ATTZ est beaucoup plus élevée que celle des masses d'eau permanentes dans les réseaux hydrographiques non modifiés. Le rendement et la production de poissons sont étroitement reliés à l'étendue de la plaine inondable, tandis que le cours normal de la rivière est utilisé comme voie de migration par la plupart des poissons.

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Dans les régions tempérées, les variations de l'ensoleillement et/ou de la température peuvent modifier les effets de la crue, et l'action de l'homme sur la crue des eaux et sur les plaines inondables limite souvent la production. Une plaine inondable peut cependant se former localement par sédimentation dans un tronçon de cours d'eau modifié par un barrage de basse chute. Aussi, les rives des cours d'eau à faible débit se transforment en plaines inondables suite à la formation de levées alluviales qui les séparent du canal principal.

Les crues sont des phénomènes qui se manifestent par à-coups. Cette situation est différente de celles prises en compte par les concepts qui mettent l'accent sur les processus continus intervenant dans les eaux courantes, tel que le concept du continuum appliqué aux cours d'eau. Les plaines inondables constituent un cas particulier car elles ne sont pas tributaires de la transformation inefficace de la matière organique en amont, même si leur réserve d'éléments nutritifs dépend en partie des échanges latéraux périodiques d'eau et de sédiments avec le canal principal. La crue est un phénomène particulier par rapport aux conditions normales parce que la position d'une plaine inondable dans le réseau fluvial n'est pas un facteur qui détermine de façon fondamentale les processus observés dans ce type de milieu. Les questions soulevées par le phénomène des crues ne peuvent pas être résolues à l'aide des concepts traditionnels de la limnologie utilisés pour étudier les systèmes lotiques et lénitiques.

Hydrologists think of rivers as links in the hydrological cycle, which transport runoff water from the continents to the sea or to the center of endorheic basins (Curry 1972). Since water is a good solvent and flowing water provides kinetic energy, water transport by rivers is linked with the transport of dissolved and solid substances. However, precipitation and river discharge typically vary significantly during the annual cycle. At low discharge rates, rivers flow in well-defined channels, but at high water in natural systems wide floodplains are recurrently inundated.

River-floodplain systems provide important habitats for biota, and ecologists have tried to link the biota of river systems with local environmental conditions and to adopt existing paradigms from other aquatic systems. These attempts have met with two problems: (1) the division of ecology into terrestrial ecology and limnology; and (2) the classification of water bodies into more or less closed, lentic systems with accumulating characteristics (lakes, ponds) as outlined in traditional limnology texts (Ruttner 1952) and open, lotic systems with discharging characteristics (streams, rivers) (Hynes 1970). The transient nature of aquatic habitats in floodplains resulted in biased treatment or in their omission. When studying rivers, most limnologists restricted themselves to river channels; when studying floodplains, they concentrated on floodplain lakes, often treating them as classical lakes.

One recent theoretical construct in river ecology, the river continuum concept (RCC) (Vannote et al. 1980), is based on the hypothesis that a continuous gradient of physical conditions exists from headwater to mouth. Analogous to the energy equilibrium theory of fluvial geomorphologists, the RCC states that structural and functional characteristics of stream communities are adapted to conform to the most probable position or mean state of the physical system. Producer and consumer communities establish themselves in harmony with the dynamic physical conditions of a given river reach, and downstream communities are fashioned to capitalize on the inefficiencies of upstream processing. Both upstream inefficiency (leakage) and downstream adjustment seem predictable. Therefore the RCC purports to provide a framework that permits us to integrate predictable and observable biological features of lotic systems (Vannote et al. 1980).

In our view, the RCC suffers from two basic limitations: (1) it was developed on small temperate streams but has been extrapolated to rivers in general; and (2) it was based on a concept that had been elaborated for the river basin in a geomorphological sense but was in fact restricted to habitats that are permanent and lotic.

Most papers that discuss the RCC recognize these limitations (Winterbourn et al. 1981; Barmuta and Lake 1982; Minshall et al. 1983; Minshall et al. 1985; Statzner and Higler 1985; Sedell et al. 1989) but fail to consider the biological significance of processes within the seasonal, aquatic habitats of floodplains. It may prove acceptable to modify the RCC to account for brief and unpredictable floods in low-order streams, even for catastrophic floods which change the physical environment and "reset" systems (Cummins 1977; Fisher 1983). However, as the size of a floodplain increases, usually along with increasing river discharge, the frequency of floods decreases, and their duration and predictability increase. These changes result in a distinct geomorphological and hydrological system with an increasing ratio of periodically lentic to lotic areas. This system results in adaptations of biota that are distinct from those in systems dominated by stable lotic or lentic habitats.

Recently, the importance of river-floodplains to fish populations in temperate, subtropical, and tropical regions has been shown by Lambou (1959), Holčík and Bastl (1976, 1977), Bryan and Sabins (1979), Welcomme (1979, 1985, 1989), Bayley (1980, 1981a, 1983), Junk (1980, 1984), and Littlejohn et al. (1985). These studies have signaled a renewed appreciation of pioneer work by Antipa (1911, 1928) and Richardson (1921). The status of the forest in subtropical river-floodplain systems has been summarized by Gosselink et al. (1981) and Wharton et al. (1981). The biases and inadequacies of limnological paradigms when applied to floodplain systems were recently discussed by Bayley (1980, 1983), Junk (1980, 1984), and Junk and Welcomme (1989) based on their experience in tropical systems. Amoros et al. (1986) and Bravard et al. (1986), who analysed the impact of flood regulation on plant and animal communities of the Rhône R. floodplain, stressed the importance of lateral and vertical dimensions of the river–floodplain system. Davies and Walker (1985) emphasized that considerable modification of the RCC was required before it could be applied to large river systems.

In this paper we synthesize evidence that suggests a complementary concept, the "flood pulse", that attempts to explain the relationship between the biota and the environment of an unmodified, large river–floodplain system. This concept is based on our experiences in relatively pristine systems in the neotropics and Southeast Asia and in the Upper Mississippi R. We derive this concept from the known ecology of typical biota that have adapted to the geomorphology and hydrology of large river–floodplain systems.

The Flood Pulse Concept

We propose that the pulsing of the river discharge, the flood pulse, is the major force controlling biota in river–floodplains. Lateral exchange between floodplain and river channel, and nutrient recycling within the floodplain have more direct impact on biota than the nutrient spiralling discussed in the RCC (Vannote et al. 1980). We postulate that in unaltered large river systems with floodplains in the temperate, subtropical, or tropical belt, the overwhelming bulk of the riverine animal biomass derives directly or indirectly from production within the floodplains and not from downstream transport of organic matter produced elsewhere in the basin.

The effect of the flood pulse on biota is principally hydrological. We postulate that if no organic material except living animals were exchanged between floodplain and channel, no qualitative and, at most, limited quantitative changes would occur in the floodplain (Bayley 1989). The relative importance of imported versus recycled inorganic nutrients in floodplains is not clear and probably varies between systems. Given similar hydrological conditions, the longitudinal position of a floodplain in the drainage network is of little importance with respect to the biota.

The Highway Analogy

Faunal life histories in unaltered large river–floodplains can be viewed as analogous to vehicles on a highway network. Were non-terrestrials to investigate this network, they would observe numerous bodies traveling in opposite directions and might well surmise that resources for those bodies were derived from the highways. If funds permitted a detailed study, it would reveal that four-wheeled creatures need to leave highways periodically for sustenance, along with their apparently symbiotic occupants. Eventually, major sources of production would be identified in farms, oil fields, and mines, vehicles consuming and distributing resources via the highway network as a response to production cycles and long-term economic changes.

The life histories of major plant and animal groups, in particular fish, in large river–floodplains are beginning to be understood sufficiently to contribute to the theory that the river network in a river–floodplain system is in many ways analogous to a highway network with the vehicles corresponding to the fish. Detritivores, herbivores, and/or omnivores support large fisheries in the main channel (Petrere 1978, 1982; Welcomme 1979; Quirós and Baigún 1985), but the highest yields are associated with adjoining floodplains (Richardson 1921; Lowe-McConnell 1964; Petrere 1983) and most of their production is derived from floodplain habitats (Welcomme 1979; Bayley 1983). The main channel is used principally as a route for gaining access to adult feeding areas, nurseries, spawning grounds, or as a refuge at low water or during winter in temperate zones. An analogous situation is found in large north-temperate and arctic rivers where most of the ichthyomass is anadromous; here the main feeding grounds are found in the delta area or in the sea (Grainger 1953; Andrews and Lear 1956; Foerster 1968; Roy 1989).

We will describe the functions of the floodplain and main channel in large river–floodplain systems with respect to the biota and evaluate the links between them and the nonfloodable watershed in the light of recent data.

Definition of a Floodplain

Terms applied to classical limnological and terrestrial systems can be inappropriate for explaining concepts in river–floodplains. This is not merely a semantic discussion because the classical terms are understood to define features and functions in their respective systems.

The "active floodplain" of a river is defined by North American hydrologists as the area flooded by a 100-year flood (Bhowmik and Stall 1979). This period is arbitrary, longer than most existing records, and has little ecological meaning. Bayley (1981b) noted that huge areas of shallow, very acidic, largely deoxygenated swamp occur in the Peruvian Amazon. These areas are distant from the main channels and inhospitable to the bulk of aquatic animals. He proposed an active floodplain that excluded these peripheral swamps in order to compare fish production and fishery yields among systems.

We define floodplains as "areas that are periodically inundated by the lateral overflow of rivers or lakes, and/or by direct precipitation or groundwater; the resulting physicochemical environment causes the biota to respond by morphological, anatomical, physiological, phenological, and/or ethological adaptations, and produce characteristic community structures". This ecological definition recognizes that flooding causes a perceptible impact on biota and that biota display a defined reaction to flooding. Furthermore, it implies that the impact of water level pulsing on biota is independent of the nature of its source and that there are many ecological similarities between floodplains adjacent to, for example, pulsing lakes or reservoirs and pulsing rivers. The definition encompasses a wide hydrological spectrum from short- to long-duration floods and from unpredictable to predictable timing. Our examples from large river systems exhibit predictable flood pulses of long duration.

We have termed the floodplain area the "aquatic/terrestrial transition zone" (ATTZ) because it alternates between aquatic and terrestrial environments. We use this term to stress our more specific definition of floodplain, because 'floodplain' has often been defined to include permanent lentic and lotic habitats. The inshore edge of the aquatic environment that traverses the floodplain (ATTZ) we have termed the "moving littoral". The floodplain or ATTZ has unique properties that have been considered to comprise a specific ecosystem (Junk 1980; Odum 1981).

Hydrologists consider the river and its floodplain as one unit since they are inseparable with respect to the water, sediment, and organic budgets. We term this unit the "river–floodplain system". Therefore, this system comprises permanent lotic habitats (main channels), permanent lentic habitats, and the floodplain (ATTZ). Many limnologists have difficulty defining floodplains viz a viz other aquatic systems, and they have defined artificial, stable borders between land and water. Conversely, floodplains are ecosystems with water boundaries that recurrently traverse large areas. The environmental change from the aquatic to the terrestrial phase at a specific point in a floodplain (ATTZ) may be as severe as the change from a lake to a desert. Classical limnological terms describing morphological features of lakes or rivers (e.g., shoreline, littoral, profundal, size, depth) are unsuitable and must be redefined or qualified, because they have become time-dependent in the floodplain. This time dependency is important because it affects the productive processes and the life cycles of plants and animals. Pieczyńska's (1972) definition of eulittoral appears to have functional parallels with our definition of a floodplain; however, the eulittoral occupied a very small part (±5%) of the nonfloodplain lakes in her study and responded to a pulse amplitude of only about 40 cm. Also, we are cautious about drawing close parallels with the intertidal zone because the time scale of the tidal pulse is so much shorter, and is brief compared with the generation times of the higher biota.

Distinctions between aquatic and terrestrial organisms and processes have proved useful in studies of rivers and lakes with well-defined borders. The ecologist's view of floodplains, however, may vary according to the group of organisms being studied. Many of the organisms colonizing floodplains have developed adaptations that enable them to survive during an adverse period of drought or flood and even to benefit from it; thus neither a purely aquatic nor a wholly terrestrial view is appropriate.

Fisheries biologists tend to consider main channels and their floodplains as a single unit, because both are essential for the survival of fish stocks (Holčík and Bastl 1976; Welcomme 1979; Bayley 1980, 1981a, 1983). Conversely, studies of floodplains linked to African rivers or reservoirs show that they are also important for terrestrial game animals in adjacent nonflooded savannas, because the floodplains determine survival rates during the dry period (Sheppe and Osborne 1971; Davies 1985).

Were we to follow the arguments of hydrologists, all plant and animal material produced in a river–floodplain system would be autochthonous because it derives from riverine sediments and dissolved nutrients. Allochthonous would refer to the material introduced from outside the river–floodplain system. In limnological literature, however, the term autochthonous is applied to biota produced in the aquatic environment, and all terrestrial material is thereby classified as allochthonous. Oscillation between aquatic and terrestrial phases in floodplains makes the limnological differentiation of organic material according to its origin misleading. Similarly, the riparian zone, as understood in temperate areas, is difficult to define in a river–floodplain system. Consequently, we avoid unqualified references to these terms.

We have defined floodplain (ATTZ), river–floodplain system, and moving littoral, and explained why traditional limnological and hydrological paradigms are not appropriate from an ecologist's view. We now use examples to describe the effects of the flood pulse on biotic and abiotic components of the river–floodplain system.

Hydrology

The hydrological regime of rivers reflects the climate of its upstream catchment area. Low order streams have an irregular flood pattern with numerous peaks because they are strongly influenced by local precipitation. This influence generally diminishes with increasing size of the watershed and is almost imperceptible in the hydrograph of very large rivers.

The hydrological buffering capacity of a large catchment area results in a rather smooth and predictable flood curve. In mainly tropical or subtropical systems with large watersheds, the hydrograph reflects seasonality in precipitation, and typically shows only one pronounced flood peak per year. A few tropical rivers, e.g., the Zaire R., show two flood peaks due to two rainy seasons in their catchment areas. In temperate and cold climates, the impact of precipitation on the hydrograph is modified by the temperature regime. For example, minor flooding occurred in autumn in the Upper Mississippi R. prior to dam construction (Grubaugh and Anderson 1989a) because evapotranspiration rates decrease as temperature drops. Also, water accumulates as snow and ice in winter, which then contribute to the spring flood by melting.

Due to the size of large river basins, the effects of seasonal climatic changes may be felt downstream only after several weeks or even months. This time lag can be of ecological importance in downstream parts of large river systems. In the central Amazon the river is still rising at Manaus after the termination of the major rains; the flood peak follows the rainy season by 4–6 weeks. On the lower Mississippi R., cold water from melting snow in the head waters passes when the temperature in the backwaters of the floodplain is already much higher (Bryan et al. 1976; Holland et al. 1983).

The shape of the hydrograph depends not only on the discharge characteristics of the river, but also on valley slope, floodplain size, and vegetation. Although the Illinois R. has a mean discharge of only 627 $m^3 \cdot s^{-1}$ (Fitzgerald et al. 1986), it has protacted floods characteristics of a much larger river because it occupies a wide river valley carved by the ancestral Mississippi and Teays rivers. Because the valley has filled with alluvium, its gradient is very flat and the river drops only 1.6 $cm \cdot km^{-1}$.

At a given rate of discharge increase, the water level rises more slowly as the floodplain begins to fill. In larger floodplains the rate of rise is slower, the period of inundation increases, and more lentic habitats develop. As the water recedes, processes in the floodplain become less dependent on the river channel and more subject to local climatic events. During the terrestrial phase, the amount and distribution of local rains greatly affects the composition and productivity of plant communities as well as the life cycles of many animals. When local precipitation at low water is high, floodplains are forested, e.g., in the middle and upper Amazon, Zaire, and Mississippi rivers. Conversely, when local precipitation is low, savannas with gallery forest develop, e.g., in the floodplains of the lower Nile, Zambezi, and Volta rivers. Some lakes and swamps are isolated from the main channel for many months or even years. Their hydrological regimes are therefore independent of the main channel except during periods of high water.

Nutrients

According to hydrologists, a river's chemistry reflects its catchment area. This holistic view has been applied successfully to streams with respect to their nutrient budgets (Hynes 1975; Vannote et al. 1980). Nutrients can roughly be divided into inorganic and organic fractions; these in turn can be subdivided into gaseous compounds, dissolved solids, and particulate matter. The floodplain receives all classes of nutrients directly from the main channel, and its basic nutrient status would be expected to correspond to that of the river. Floodplains, however, tend to establish their own cycles since organisms and environmental conditions that influence the biogeochemical cycles differ considerably from those in the main channel. The effects of rain, runoff, groundwater, and input from floodplain tributaries may also be important.

The Inorganic Fraction

Gaseous Compounds

Gases such as CO_2, O_2, H_2S, CH_4, and N_2 are produced and/or consumed in the floodplain independently of processes in the main channel in systems with slow, regular flood pulses. Residence time of floodplain water and temperature modify concentrations. The lack of persistent thermal and chemical stratification in most Atchafalaya floodplain lakes is due to the short period of lentic conditions during warm weather (Bryan et al. 1974). In contrast, the water column becomes chemically stratified over large areas soon after entering the Amazon floodplain; the daily thermocline with a temperature difference of 1–3 °C is sufficient to inhibit circulation deeper than 2–6 m during periods of several weeks or even months. Large amounts of organic material under decomposition at high temperatures result in high rates of oxygen consumption and CO_2 release near the bottom. Hypoxic, or even anoxic conditions accompanied by H_2S and CH_4 production, are often found at a few metres depth (Schmidt 1973a; Melack and Fisher 1983; Junk et al. 1983).

In addition to nitrogen input from the river, high nitrogen fluxes to and from the atmosphere occur. These fluxes are related to oxygen levels and to organisms in water and soils, both of which change drastically between flood and dry periods. Denitrification in wetlands is well documented (Kemp and Day 1984) and has even been used in the treatment of wastewater (Dierberg and Brezonik 1984). Various nitrogen-fixing organisms, e.g., cyanophytes and bacteria, that are often associated with higher plants such as Leguminosae counteract denitrification by fixing atmospheric nitrogen (Heller 1969; Richey et al. 1985). Despite the high potential for denitrification, Brinson et al. (1980) consider tupelo-cypress swamps to be nitrogen sinks due to high nitrogen levels in the litter.

Dissolved Solids

River water is the major source for dissolved inorganic compounds, including plant nutrients. Abiotic and biotic processes in the floodplain, however, may considerably alter the total amount and ionic composition of dissolved materials. Increased evaporation may raise salinity in backwaters above the levels found in the river, in particular in arid climatic zones. Biogenic modifications are reported from Amazonian floodplain lakes where ten to twentyfold increases in total salinity have been measured in small pools at low water (Furch et al. 1983). A major change in ionic composition, such as an increase in potassium, has been principally associated with leaching of decomposing aquatic and terrestrial macrophytes (Furch 1984a, 1984b; Furch et al. 1983).

Further changes in ionic composition result from dilution by local rains or by mixing with lateral inflows of surface and ground water from nonflooded areas. During low river stages in the Amazon, water seeping through floodplain sediments has an electric conductance up to 200 times that of the Amazon R. water, with high levels of iron and manganese (Irion and Junk, unpublished data).

Levels of dissolved nutrients are seldom limiting factors for primary production in the main channels of large rivers. In the floodplain, however, phosphorous and/or nitrogen often limit productivity, and inflowing river water replenishes the nutrient levels, as shown for phytoplankton production in Amazonian floodplain lakes (Fisher 1979). In lake and swamp habitats receiving minimal influence from the Atchafalaya R., heterotrophic phytoplankters (flagellated euglenophytes and pyrrophytes) predominated during low water levels in association with minimal inorganic nutrients (Bryan et al. 1976; Seger and Bryan 1981).

Little is known concerning the amount of dissolved inorganic compounds released from the floodplain into the main channel, and findings are contradictory for phosphorous (Yarbro 1983) and nitrogen (Brinson et al. 1983). Release and storage may be related to the flood cycle and to vegetation cover, and in temperate regions, to the growth cycle of the vegetation (Klopatek 1978; Brinson et al. 1980). Because large floodplains represent a mosaic of habitats with different physical and chemical conditions supporting diverse biotic communities, they may act either as a sink, or as a source with respect to each nutrient, depending on the circumstances.

Particulate Matter

Particulate inorganic matter in suspension is normally considered an unimportant source of plant nutrients in the river channel. Conversely, such particles hinder growth of phytoplankton and submersed aquatic macrophytes due to shading. In floodplains, however, they become a basic part of the nutrient pool available to primary producers in the dry phase and during part of the wet phase. Fertility of floodplains depends largely upon the quality of deposited sediments. Irion (1983) states that transport and deposition of sandy and kaolinitic material produce an infertile floodplain (e.g., Rio Negro in Brazil), whereas the montmorillonite and illite of the Amazon and Mississippi rivers result in high floodplain fertility. However, an impoverishment of some mobile elements (Fe, Mn, Zn) was detected in the upper 10 m-layer of Amazon sediments, which are only a few hundred years old (Irion et al., unpublished data). Conversely, weathering of the sediments, which is accelerated in tropical climates, adds dissolved inorganic materials.

The Organic Fraction

According to the RCC, aquatic animal communities of low-order streams depend mainly upon material from the nonflooded watershed. Medium-order streams have an increased instream production. Fauna of high-order rivers lacking floodplains depend mainly on organic material from upstream areas because primary production in the main channel is very low (Vannote et al. 1980).

Practically all litter must be processed by microorganisms if it is to become attractive to higher consumers. A considerable portion continues to be practically indigestible, such as fine particulate organic material in the Amazon main channel (Hedges et al. 1986). Ertel et al. (1986) reported that humic materials comprised 60 % of the dissolved organic carbon of the Amazon main channel; this carbon in turn made up about 50 % of the total organic carbon. The comparatively low BOD of the water from the main channel of the Amazon itself contrasts sharply with values in its floodplain (Junk, unpublished data).

Part of the organic carbon transported in the main channel passes on to the floodplain. This amount, however, is negligible in comparison with in situ production of organic material in the floodplains of rivers (Bayley 1989). Estimates of the productivity of the Amazon floodplain show that annual primary production is of the same order of magnitude as the total amount of carbon transported by the river to the Atlantic Ocean (Richey et al. 1980; Junk 1985a).

The direct impact of floodplains on the carbon budget of main channels is not well known. Some evidence suggests that floodplains can be a source for particulate and dissolved carbon (Chowdhury et al. 1982; Martins 1982; Junk 1985a; Furch and Junk 1985; Grubaugh and Anderson 1989b). Conversely, retention mechanisms, such as settling of particulates, uptake by organisms, and retention of most macrophytes by stranding or trapping during falling water (Junk 1980) contribute to the recycling of most carbon in the floodplain and strongly reduce leakage to the river channel. Carbon export from floodplains also depends on hydroperiod, flushing rate, and in temperate regions, on the growth cycle of floodplain vegetation. Data from floodplains are limited, but Odum and de la Cruz (1967) estimated that the rate of export of organic material from a Georgia tidal marsh was directly proportional to volumetric flow rates.

Gosslink et al. (1981) assumed that flooding during winter and spring provides more detritus to main channels than during summer in temperate regions. In the tropics, consistently high temperatures favor high production and rapid processing of organic material throughout the year.

Biota in the River Channel

The channel is well defined in large, pristine rivers, and is delineated from the floodplains by natural levées and/or a marked increase in water velocity. In rivers modified by navigation dams, such as the Mississippi, broad, slow-flowing main channel borders are found on either side of the narrow main channel, which is defined by the thalweg (Fremling et al. 1989). These borders, which constitute a developing floodplain, are discussed separately below; however, the main channels of modified rivers have much in common with those in more pristine systems.

Plants

Great water depth, high suspensoid load, considerable turbulence, and strong current make the main channel unfavorable for primary production. Aquatic macrophytes and periphyton normally colonize shores and, in some transparent tropical rivers, rocky substrates (Podostemaceae). In slow-flowing tropical and subtropical rivers floating macrophytes may become important. Phytopotamoplankton density increases with stream order, transparency, and decreasing current velocity, but absolute values are low (e.g., Berner 1951). In most large rivers, physical factors, in particular light, rather than mineral nutrients limit primary production (Fisher 1979). Average primary production per unit area in the main stems of large turbid river systems such as the Amazon, Mekong, Ganges, and Mississippi can be only a small fraction of that in their floodplains.

The extent to which floodplain water bodies contribute to populations of potamoplankton and floating macrophytes in large rivers is unknown. The considerable increase of potamoplankton downstream of reservoirs, e.g., in the Nile (Brook and Rzóska 1954; Talling and Rzóska 1967; Hammerton 1976) and the increase of floating macrophytes in the Amazon main channel at rising and high water (Junk 1970) are due to high production of these plants in associated lentic habitats.

Invertebrates

Little information is available about colonization by animals of the bottoms of large rivers. The bed loads of large rivers in alluvial plains, e.g., the Mississippi, are sandy (Schumm 1977). Large river channels mostly consist of a monotonous sequence of slowly moving sand dunes unsuitable for benthic organisms. The Amazon R., for example, transports its bed load of coarse sand as dunes 6–8 m high (Sioli 1984).

High suspensoid loads hinder benthic and epizoic animals (Hynes 1970). Junk (1973) found a decrease in number and biomass of principally filter-feeding perizoon in floating macrophyte vegetation as amounts of inorganic suspensoids increased.

Although some invertebrates can live in the dominant sandy substrates of main channels (e.g., the chironomids *Gillotia*, *Cyphonella*, *Robackia*, and *Saetheria* [Coffman and Ferrington 1984]), densities are low. Berner (1951) and Morris et al. (1968) indicated average fresh invertebrate biomasses in the main channel of only 0.001 $g{\cdot}m^{-2}$ and 0.007–0.048 $g{\cdot}m^{-2}$, respectively, for the Missouri R., and attributed these low values to shifting substrates, siltation, fluctuating water levels, swift current, and absence of aquatic vegetation. In the Atchafalaya distributary, which receives 80 % of the Mississippi R. discharge, Bryan et al. (1976) reported a mean quantity of 327 benthic individuals per m^2 in riverine habitats compared with densities up to ten times greater in floodplain habitats.

Logs and rocks provide stable substrates for organisms in a channel environment that is otherwise dominated by shifting alluvium. Over 10^6 logs were pulled from channels in the lower 1600 km of the Mississippi during a 5-year period (Harmon et al. 1986). The average fresh animal biomass colonizing logs in the Kaskaskia R., Illinois, varied between 0.57 and 1.65 $g{\cdot}m^{-2}$ (Nilsen and Larimore 1973). Nord and Schmulbach (1973) reported a range of 0.2–3.2 $g \cdot m^{-2}$ dry weight in the Missouri R. Assuming an average surface area per log of 5 m^2, a dry biomass density of 2 $g \cdot m^{-2}$ of log, and an average width of the lower Mississippi channel of 900 m, the overall biomass density of this fauna would be only 0.007 $g \cdot m^{-2}$.

Vertebrates

Vertebrates, particularly fish, are important consumers in the main channel. In subtropical and tropical rivers, freshwater dolphins, capybaras, manatee, hippos, turtles, and crocodiles may contribute considerably to the main channel biomass. White whales and seals occur in arctic rivers; beavers, muskrats, and otters in temperate rivers; and waterfowl and shorebirds in both. However, few higher animals have adapted to utilize main channel habitats exclusively. Those that do tend to be predators whose prey depends largely on production in floodplain habitats, such as large, piscivorous catfishes (Goulding 1981), to some extent river dolphins (Ferreira da Silva 1983), and fish that consume aquatic invertebrates (Lundberg et al. 1987). In the main channels of the Mississippi and Missouri rivers, pallid sturgeon (*Scaphirynchus albus*), blue sucker (*Cycleptus elongatus*), blue catfish (*Ictalurus furcatus*), and several chubs (*Hybopsis* spp.) feed largely on invertebrates, and, with respect to large pallid sturgeons and blue catfish, on fish (Pflieger and Grace 1987).

Most vertebrates use the main channel temporarily as migration routes, for spawning, as refuge during droughts or freeze-up, or for hibernation. Tropical rivers are famous for large-scale migrations of fish for dispersal and/or spawning in the main channel or floodplain, that result in large biomass densities in the main channel during falling or low-water periods (Godoy 1967; Bonetto et al. 1969a; Bayley 1973; Ribeiro 1983). Large channel catfish (*Ictalurus punctatus*), flathead catfish (*Pylodictis olivaris*), and freshwater drum (*Aplodinotus grunniens*) use drop-offs, scour holes or obstructions in or along the main channel of the Upper Mississippi R. for a winter refuge (Hawkinson and Grunwald 1979).

Except for limited amounts of potamoplankton, benthos, and predators, the biota of the main channel concentrate close to the river shoreline, to islands, or in the main channel border areas described below, areas where habitat diversity increases and food supply improves (edge effect). Therefore the "bank coefficient" (Sedell et al. 1989) is an index of the productivity potential of a river channel in the absence of a floodplain. Conversely, when a regularly inundated floodplain is present, most of the vertebrates found in the main channel depend to a great extent directly or indirectly on primary production in the laterally linked floodplain habitats.

Biota in the Floodplains

Flood Pulsing and Life Cycles

Life cycles of biota utilizing floodplain habitats are related to the flood pulse in terms of its annual timing, duration, and the rate of rise and fall. Timing is important in temperate rivers where seasonal temperature and light cycles also regulate productivity.

Because the ATTZ has pronounced aquatic and terrestrial phases, there are strong selective pressures on aquatic organisms to colonize it at rising or high water because of the feeding opportunities (Bonetto et al. 1969b; Welcomme 1979; Bayley 1983, 1988). Conversely, terrestrial organisms that occupy nonflooded habitats along the floodplain borders are adapted to exploit the ATTZ at low water levels (Sheppe and Osborne 1971; Fredrickson 1979; Davies 1985).

In low-order streams, the level of adaptation to flooding is rather low. For many organisms, unpredictable floods correspond to catastrophic events that periodically "reset" the physical and biotic environment (Cummins 1977; Fisher 1983). Obligate aquatic organisms concentrate mostly in the main channel because flood periods are too short and irregular to develop profitable strategies for occupying the ATTZ.

The predictable and prolonged flood pulse typical of large rivers favors the development of anatomical, morphological, physiological, and/or ethological adaptations of terrestrial and aquatic organisms in order to colonize the ATTZ as shown by Adis (1979) and Irmler (1981) for Amazonian terrestrial invertebrates and by Uetz et al. (1979) and Wharton et al. (1981) for N. American floodplains.

In the humid tropics, regular flooding and drying of floodplains provoke a pronounced seasonality in an otherwise unseasonal environment. Many Amazonian floodplain trees show distinct annual growth rings, because inundation causes a "physiological winter" through oxygen stress (Worbes 1985, 1986). Seed production is timed with the flood for dispersal by water or by fish (Gottsberger 1978; Goulding 1980). Terrestrial arthropods from central Amazonian floodplain forests show a defined reproduction period (Adis and Mahnert 1986; Irmler 1986) but are polyvoltine in neighboring dryland forests (Adis and Sturm 1989). The flood cycle has been hypothesized as the driving force behind species selection ("taxon pulse", Erwin and Adis 1982) and the acquisition of an annual seasonality that enabled tropical insects to colonize temperate zones (Paarmann et al. 1982; Adis et al. 1986). The regular pulsing of large rivers may have been as important for the development of biorhythms in the tropics as was the pulsing of the light/temperature regime in temperate regions or the change between dry and wet periods in the arid and semiarid tropics.

Because many vertebrates living in the main channel depend on the floodplain for food supply, spawning, and shelter, they have developed strategies to utilize periodically available habitats. High mobility is required, as witnessed by the extensive migrations referred to earlier. Such strictly aquatic animals as fish and manatees depend on the flood cycle of the river, which controls access to the floodplain. Others less strictly aquatic, such as hippos, beavers, or capybaras, make feeding trips out of the water.

The importance of lateral migration of animals between the floodplain and main channel of large river systems has been underestimated because modern civilization has substantially modified the hydrograph and separated floodplains from main channels. These modifications dominate large temperate river systems. The biologist's typical view of fish in temperate rivers has been that they complete their life cycles within the river channel. Indeed, fish have no alternative in sections of some highly altered systems such as major stretches of the Mississippi R. Their persistence in these areas attests to their great plasticity in coping with habitat change.

Fishes that depend on seasonal colonization of floodplain habitats dominate the fisheries, the biomass, and the production in river–floodplain systems (Bonetto et al. 1969a; Welcomme 1979; Bayley 1981a; Goulding 1981; Bayley 1983; Littlejohn et al. 1985). Spawning of many species occurs at the beginning or during some period of the rising flood, resulting in timely colonization of the floodplains for feeding and shelter (Bayley 1983, 1988; Holland et al. 1983; Welcomme 1985). Conversely, when the water recedes, fish find refuge in main channels, in residual floodplain water bodies, or in permanent tributaries (Welcomme 1979).

Adults of many species show seasonality in food uptake related to flood cycles, as shown for the Rupununi R. by Lowe-McConnell (1964) and for the large rivers of the Amazon basin by Goulding (1980, 1981) and Ribeiro (1983). Periods of fasting coincide with low or falling water levels and are associated with decreases in seasonal fat content in many adult fish (Junk 1985b). Studies of diets at rising and high water show that many species directly use pollen, fruits, seeds, and the small portion of terrestrial insects that drop into the water from the canopy of the forest (Goulding 1980).

Detritus plays a major part in the food webs in floodplains (Welcomme 1985). Fish are major detritivores in the tropics. For example, fine particulate organic matter (FPOM) is consumed directly by the highly specialized Prochilodontidae and Curimatidae in South America, and by Citharinidae and *Labeo* species in Africa (Bowen 1984; PBB, pers. obs.). Coarse particulate organic matter (CPOM) features in the diet of many omnivores in the Amazon (Almeida 1980; Santos 1981).

FPOM is also an important feature of the gut contents of large catostomids and *Dorosoma* in large N. American rivers, but its nutritional importance has only recently been indicated (Ahlgren 1988). Most of the commercially important fishes are bottom feeders utilizing macroinvertebrates, which in turn ingest detritus (Fremling et al. 1989).

The importance of remnant floodplain areas in the Mississippi and its tributaries was indicated by Risotto and Turner (1985), who found that 55 % of the variation in average fish catch was explained by bottomland hardwood area (as a proxy to floodplain area), fishing effort, and latitude. Because some bottomland forest is now cut off by manmade levees and not all floodplains are forested, the relationship might be improved with direct measurements of the active floodplain areas.

Adaptations to survive hypoxic conditions favor the colonization of periodically stagnant waters typical of many floodplains. Air breathing and other adaptations to low oxygen concentrations are frequently found in neotropical fishes (Carter and Beadle 1931; Kramer et al. 1978; Junk et al. 1983), other tropical floodplain rivers (Welcomme 1979), and in fish of the Mississippi drainage (e.g., gars, *Lepisosteus* spp. and bowfin, *Amia calva*; see also Marvin and Heath 1968).

In the temperate Upper Mississippi R. floods can reduce the overwinter survival of young-of-the-year freshwater drum (*Aplodinotus grunniens*) by the influx of channel water at 0°C into backwater thermal refuges where the temperature is 4°C (Bodensteiner and Sheehan, in press). The winter biology of fishes in large North American rivers has been little studied, and the recruitment of other species may be strongly affected by winter temperatures and flood patterns. From spring through summer, the timing and duration of the flood is critical to species which gain access to the ATTZ and permanent backwaters for feeding and spawning. Ideal conditions for spring spawners occur during years in which the flood and temperature rise are coupled; conversely, recruitment is poor if the flood retreats too soon during the warm growing season (Fig. 1). Finger and Stewart (1987) found that the timing and duration of flooding controlled the year-class dominance of spring- versus summer-spawners in Missouri floodplain forests.

In polar, sub-arctic, and taiga rivers the timing of the flood is predictable because of massive snow melt in the spring. However, the flood is accompanied by ice that scours the floodplains and subsequently recedes rapidly,

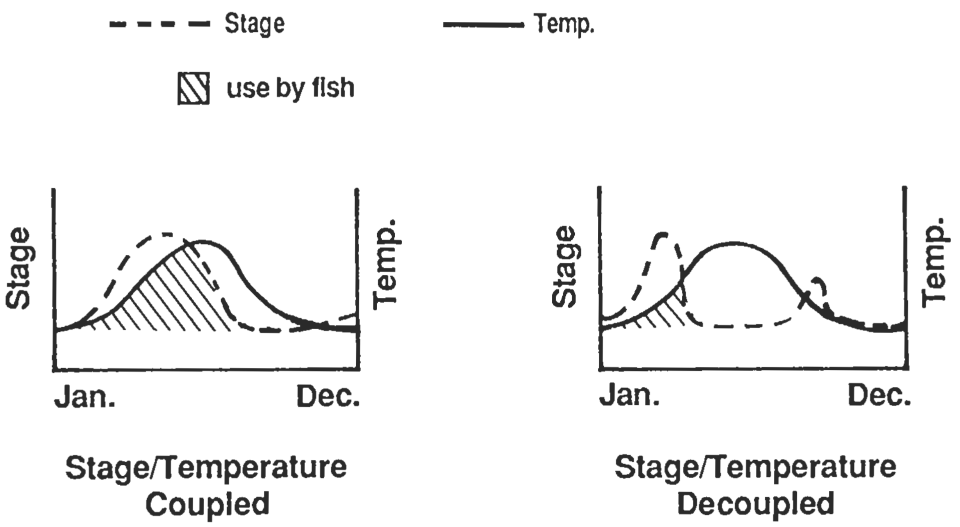

FIG. 1. Schematic of combinations of river stage and water temperature in temperate river–floodplain systems (see text).

creating an inhospitable environment for fishes (Roy 1989). The severe springtime conditions may explain why fish in high latitudes avoid the flood by spawning in the fall (R.A. Ryder, personal communication).

Tree growth is mainly retarded by floods because the rhizosphere becomes deoxygenated (Huffman 1980; Huffman et al. 1981). Gosselink et al. (1981) postulated that floods during winter or spring have a positive effect on the floodplain forest because they distribute nutrients and water to the soil before plant growth commences. Data on flood tolerance of tree species often appear to be contradictory because the timing of floods relative to growth and resting periods is not stated (Dister 1980).

The Mississippi R. is a major migratory flyway for waterfowl, shorebirds, gulls, and eagles. The dabbling ducks (mallard, pintails, greenwing and bluewing teal, black duck) utilize mast in floodplain forests, waste grain in adjacent harvested fields, and invertebrates associated with macrophytes in shallow water bodies, as well as the seeds, tubers, and plant leaves in the floodplain (Bellrose 1941). The diving ducks (canvasback, lesser scaup) utilize submerged macrophytes and macroinvertebrates that grow in deeper water (Thompson 1973). Aquatic and moist-soil vegetation in the Illinois and Upper Mississippi floodplains requires a period of shallow, stable water levels during the summer growing season (Bellrose et al. 1979). The summer's primary production is made more accessible to migratory waterfowl by the autumn rise in water levels. If an autumn flood does not occur, managers of refuges and duck clubs create one by pumping water from the river into the floodplain. They also pump water out of the same impoundments if the flood is too slow to retreat in the summer, so they can sow millet or allow native plants to grow (Bellrose et al. 1979).

Flood Pulsing and Plant Community Structure

Under given climatic conditions, plant communities become established in the ATTZ of large rivers according to the flood regime. Every place in this zone can be considered a point on a gradient reflecting the degree of annual flooding. Every plant has its optimum position on this gradient. The optimum, however, can be modified by such factors as stability, structure, and fertility of the substrate, groundwater level, and biogenic processes (e.g., accumulation of organic material, nitrogen fixation, and interspecific competition) (Lindsey et al. 1961; Bedinger 1979; Burgess et al. 1973; Johnson and Bell 1976; Bell 1980; Dister 1980, 1983; Gosselink et al. 1981; McKnight et al. 1981). Distributions of animals are also affected by this gradient in spite of their mobility (Wharton et al. 1981; Larson et al. 1981).

Basic changes in plant community structure occur mainly through a shift of the gradient, such as a rise of the floodplain surface due to additional inorganic or organic sediment deposition (allogenic or autogenic succession), a lowering by erosion, or a change in the hydrograph due to climatic change, tectonic movement, or human influence such as the construction of a dam or lateral dikes.

Plant communities, however, are characterized by smaller changes. There is strong pressure on communities to proceed to a later successional stage when the period of the flood pulse is reduced. The shape of the pulse often varies within large limits, thereby causing communities to respond. Annual plants react to annual differences whereas forest communities are affected by extreme annual floods, droughts, or even periods of successive years of extreme flood events that may occur every 10, 20, or 100 years. Establishment of tree seedlings in low-lying areas requires a period of exceptionally low water for several years, as Demaree (1932) found for *Taxodium distichum*. Aquatic communities tend to fill up periodically isolated water bodies with organic debris, thereby causing autogenic succession to marsh and swamp vegetation when the flood pulse fails. This process has been estimated to require about 200 years in the temperate Rhône R. (Amoros et al. 1986). Extreme floods clean these water bodies and "reset" communities to earlier successional stages. Resets can be especially severe when floods occur during the ice season in temperate rivers because trees and channels can be scoured by wind- or water-driven ice (Sigafoos 1964). Consequently, the observed community structure in floodplains is a result of short-, medium-, and/or long-term effects of the flood pulse. Shelford (1954) estimated that about 600 years were required to develop the late subclimax tulip-deer-oak communities on the lower Mississippi R. Most communities receiving the full amplitude of the flood pulse can be viewed as being in a dynamic equilibrium at an early successional level (pulse-stability, *sensu* Odum 1959; see also Margalef 1968).

Flood Pulsing and Production

Primary and secondary production in the river–floodplain system is the sum of production during terrestrial and aquatic phases. As indicated previously, the basic fertility of the floodplain depends on the nutrient status of the water and on the sediments deriving from the river. This fertility, however, may be modified by tributaries and by runoff from the local catchment area of the floodplain. Length, amplitude, frequency, timing, and predictability of the flood pulse determine occurrences, life cycles, and abundances of primary and secondary producers and decomposers, abundances which affect the level of exploitation and regeneration of the nutrient pool as well as its supply.

Gosselink and Turner (1978) proposed a classification of wetland systems according to a hydrodynamic energy gradient. They suggested that a positive relationship existed between productivity and water flow. Their theory may be valid within limits in a river–floodplain system; however, short-duration pulsing can flush out considerable organic matter and nutrients into the main channel (or into the estuary from a salt marsh as shown by Teal [1962]) and limit in situ productive processes and access by aquatic animals. In such systems, the aquatic biologist studying production is concerned with how the ATTZ benefits the river or the permanent lentic areas in the floodplain. Conversely, slow inundation of the same floodplain allows sufficient time for in situ processes along the moving littoral (Fig. 2), which traverses the ATTZ with each pulse. Aquatic and terrestrial biologists studying production in river–floodplain systems with slow pulsing should be concerned with how the river benefits the floodplain.

The flooding phase of the moving littoral (Fig. 2) finds its closest parallel to a reservoir in the process of being flooded (Wood 1951), with mineralized products from any preceding aquatic cycle and the current terrestrial one being

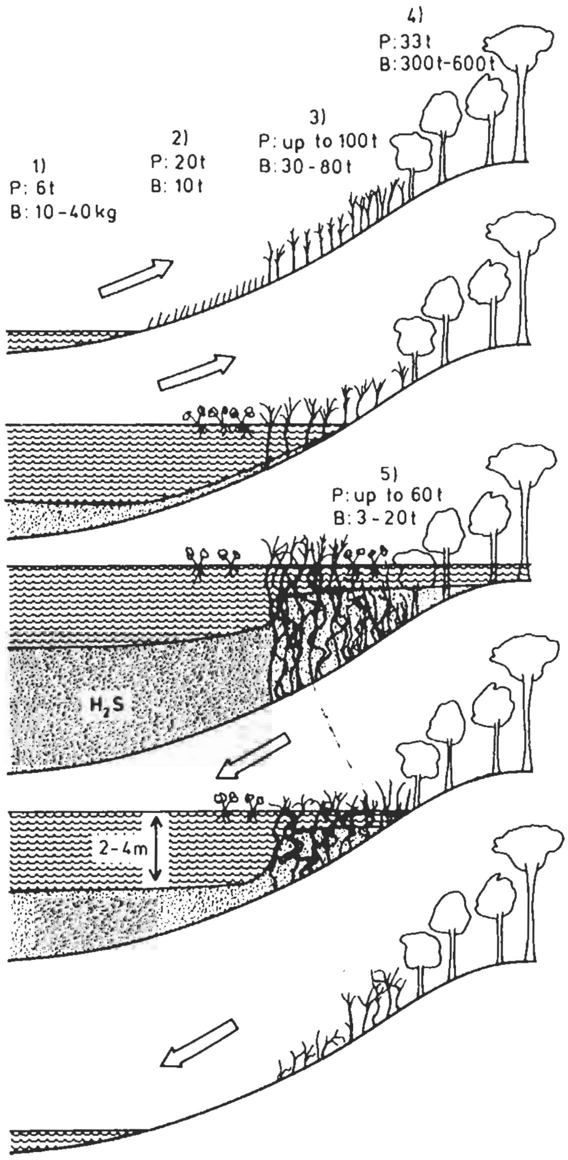

FIG. 2. The moving littoral in the transition zone (ATTZ) of a river-floodplain system in the central Amazon, with estimates of annual production (P) and biomass (B). Estimates are as dry weight per hectare. The H_2S zone has no dissolved O_2. The indicated zones are as follows: (1) Phytoplankton C14 (Schmidt 1973b), (2) annual terrestrial plants, (3) perennial grasses, (4) floodplain (várzea) forest, and (5) emergent macrophytes (from Junk 1985c and unpubl. data). Periphyton are not included, but preliminary data of periphyton on macrophytes from T. R. Fisher (pers. comm.) indicate a total productivity in the floodplain of the same order as phytoplankton (Bayley 1989).

released into the water. The various sources of primary production have high values (Fig. 2) but varying production to biomass ratios. When integrated over areas appropriate for each season in the floodplain, phytoplankton contributed less than 6 % of the total carbon production in the central Amazon várzea floodplain (Junk 1985a; Bayley 1989).

Most carbon sources, including considerable detrital biomass, are important to some animals at some time (Welcomme 1979, 1985; Junk 1984), but their quantitative importance is unknown. Organic material produced in floodplains varies considerably with respect to consistency, protein content, digestibility, and availability, that result in large differences in decomposition time and in the types of organisms involved in decomposition processes. Phytoplankton and periphyton are easily decomposed in only a few hours or days. In the Amazon, aquatic and terrestrial herbaceous plants lose about 50 % of their weight after 2–3 weeks in water (Howard-Williams and Junk 1976). Tree leaves vary widely according to species; some are as quickly decomposed as herbaceous plants whereas others remain little modified throughout months and even years. Softwood plants are destroyed in a few years, whereas hardwood plants may remain little modified for years and even decades (Junk, unpublished data).

Strong evidence suggests that the change between terrestrial and aquatic phases accelerates the decomposition of organic material, as the circumstantial evidence of Wood (1951) indicated. Terrestrial arthropods play an important role in the decomposition of leaf litter and wood as shown for cockroaches by Irmler and Furch (1979) and for termites by C. Martius (pers. comm. to WJJ). Oxygenation of sediments during dry periods promotes processing of organic material; later, when reflooding occurs, plant nutrients are recycled into the water, thereby enhancing productivity. This effect, sometimes in combination with a crop plantation or fallow period for an entire year, has been utilized for many years in European fish culture. Wood (1951) proposed the management of water levels in impoundments by changing them seasonally to increase fish production. Lambou (1959) suggested that the processes described by Wood explain the high productivity of backwater lakes due to natural water fluctuations in the Mississippi floodplain. In the Amazon floodplain during the period of rising water, mean growth increments by weight of 12 common fish species were 60 % higher than during the remainder of the year (Bayley 1988).

Food supply in fertile floodplains during the flood phase can be so abundant that factors other than food may limit individual growth and population density of fish and other aquatic animals. Limitations during the flood phase include spawning success, lack of habitats with sufficient dissolved oxygen (Junk et al. 1983), and predation (Bayley 1983). Limitations at low water include higher levels of predation, a probable reduction in food supply, or even death by drought. Bayley (1988) found that growth of juveniles of 11 abundant fish species tested did not indicate a density-dependent relationship with potentially competing species guilds during the period of rising water. Only two out of eight species indicated density-dependency at $P < .05$ during the shorter falling-water period.

The preceding ideas have very little to do with traditional concepts of productive processes in rivers. The RCC predicts that lower reaches of river systems have low ratios of production to respiration (P/R) due to processing of material from upstream and reduced in situ production. Wissmar et al. (1981) noted that Amazon floodplain lakes have high respiration rates, and Melack and Fisher (1983) noted that carbon loss due to respiration exceeds the carbon contributed by phytoplankton. However, these are limnological perspectives that describe only part of the system. The evidence offered here for the lower reaches of the river-floodplain system indicates high in situ production and low importation of organic matter from upstream. Therefore, we predict high P/R ratios for large river–floodplain systems.

Flood Pulsing and Diversity of Habitats and Species

Sediments, which are deposited in the floodplain in well-defined geomorphological units, form bars, levees, swales, oxbows, backwaters, and side channels. Flowing water grades sediments according to grain size. The floodplain soils are stratified horizontally and vertically in a small scale pattern (Irion et al. 1983; Amoros et al. 1986), but the wind-induced transport of sediment may modify the water-induced sediment pattern.

The main river and its connecting channels represent the lotic part of the river–floodplain system; oxbow lakes, abandoned channels, and backwaters represent the lentic one. Both harbour sets of organisms which colonize the much more extensive, periodically flooded ATTZ and increase species numbers occurring in the floodplain.

Differences in the duration of flooding, in soil structure, and in vegetation result in small-scale habitats in the form of narrow, roughly parallel zones. This arrangement multiplies the edge effect far beyond that represented by the main channel and its islands. In addition to these topological edges, there are many physico-chemical edges in the form of sharp vertical and horizontal boundaries in oxygen, temperature, dissolved or suspended matter; in the main channel these are encountered only at confluences with tributaries or near the substrate. In the Amazon, oxygen levels in surface water may drop from about 5 $mg{\cdot}L^{-1}$ in the main channel to 0.5 $mg{\cdot}L^{-1}$ in the floodplain 50 m away (Junk et al. 1983).

Habitats shift horizontally and vertically according to the waterlevel (Fig. 2). In addition to this instability due to the moving littoral is another instability caused by sediment deposition and erosion by the river. Depending on the position of the river channel and its dynamics, habitats may be ephemeral or rather stable over decades or centuries. This affects such stationary organisms as trees.

Nonflooded areas inside and adjacent to the floodplain perimeter, as well as emergent vegetation or the floodplain forest canopy, can be termed terrestrial habitats. All of them harbour an abundance of plants and animals that colonize the ATTZ, increasing considerably the total number of plants and animals occurring in the system.

No attempt to explain the total diversity in all habitats has been made; however, studies on specific plant and animal groups show some tendencies and some apparent inconsistencies. Species diversity would be expected to be limited in aquatic and terrestrial taxa that are sedentary and experience the full impact of the physiological stress resulting from the change between the aquatic and terrestrial phase. Worbes (1983) showed that the central Amazon floodplain forest has a much lower plant species diversity than the nonflooded forest. Salo et al. (1986), however, state that high diversity in tree species characterizing the upper Amazon lowland forests occurs in existing and relict floodplains, but they did not present species numbers or diversity indices. They describe a mosaic of small habitats created by large-scale, continuous disturbance by lateral erosion and sedimentation from the river channel, with high diversity between habitats. They reason that the high diversity in the relatively short-lived habitats of the present floodplains was due to insufficient time to allow competitive exclusion, supporting Connell's (1978) intermediate disturbance hypothesis. In the former floodplain formations that are about 5 000–10 000 years old, habitats are very stable, and the high species diversity between habitats was attributed by them to allopatric speciation.

Diversity would be expected to increase with the ability of organisms to avoid the physiological stress in the ATTZ. High diversity in floodplains occurs in mobile groups, such as fish (Lowe-McConnell 1975; Welcomme 1985) and nonaquatic birds (Remsen and Parker 1983).

The drastic change between terrestrial and aquatic phases results in high seasonal losses for most plant and animal populations, but these losses tend to be recovered by quick growth, early maturity, high reproduction rates for *r*-strategy organisms (Pianka 1970), and fast dispersal. Many of the most persistent and productive tropical aquatic weeds (e.g., *Eichhornia crassipes, Salvinia auriculata, Ceratopteris pteridoides*, and *Alternanthera philoxeroides*) are endemic to neotropical river–floodplains. In floodplains they are periodically decimated during the dry phase, allowing coexistence of many plant species with similar habitat requirements. In hydrologically stable conditions, they become dominant due to their strong competitive ability. Conversely, many persistent weeds in agricultural crops dominate in the early successional stages of floodplain vegetation at low water due to their *r*-strategy traits and recurrent disturbance of the ATTZ by the flood pulse (Seidenschwarz 1986; WJJ, unpublished data).

Many plants and animals show an impressive resilience with respect to short-term catastrophic events; an example is the rapid response of fishes following extreme drought, overfishing, or poisoning. Due to their highly effective reproduction strategies and to their mobility which allows access to dispersed low-water refuges, fish recover quickly when the flood pulse returns (Welcomme 1979). An *r*-strategy is effective only when sufficient nutrient and food resources are available to fully utilize the growth potential. Floodplains of extremely low nutrient status may therefore favor *K*-selection (Pianka 1970), such as Magalhães and Walker (1989) have indicated for Amazonian freshwater shrimps.

If we consider the total number of species in a river–floodplain system, circumstantial evidence suggests that a physical factor, the flood pulse, produces and maintains a highly diverse and dynamic habitat structure, thereby allowing a high species diversity despite stresses in the ATTZ. This is consistent with the intermediate disturbance hypothesis of Connell (1978) and parallels the observations of Statzner and Higler (1986) and Statzner (1987) who noted that physical factors (stream hydraulics) affected zonation patterns of benthic invertebrates, and that longitudinal zones of transition were associated with higher species richness.

Man-Made River-Floodplains

Dams have altered the hydrology and created artificial sedimentation basins covering thousands of square kilometres in rivers worldwide. Dam construction continues. For example, about 100 large reservoirs totalling 100 000 km^2 are projected to utilize the hydroelectric potential of Amazon R. tributaries (Junk and Melo 1987).

The hydrological changes often remove the flood pulse from floodplains downstream and sometimes permanently inundate floodplains upstream.

In the longer term, sedimentation and the modified flood pulse produce man-made river–floodplains. The 26 mainstem navigation dams on the Upper Mississippi R. downstream from Minneapolis, Minnesota, divide the river into reaches where the entire floodplain width immediately upstream of the dam is currently inundated, but where sedimentation is creating shallows that will become levées, side channels, or backwaters, and eventually floodplains (Fig. 3A to H). Of course, former floodplains now behind manmade levées will remain isolated from the river, assuming no long-term changes in flood stages or flood protection policy. The new floodplains upstream from some of these dams will experience the full amplitude of the flood cycle because the dams maintain water depths for navigation only during low flows but have little effect on flood levels. Indeed, the gates are raised completely out of the water and the relatively low earthen weirs that connect the locks and gates to the bluffs are overtopped during floods. The extent to which these developing floodplains contribute to secondary production, fish yield, and waterfowl utilization should be measurable during the next 50 years, assuming that other factors (e.g., pollution) remain constant or are taken into account. Thus the flood pulse concept can be investigated by measuring changes in one system through time since the navigation dam construction.

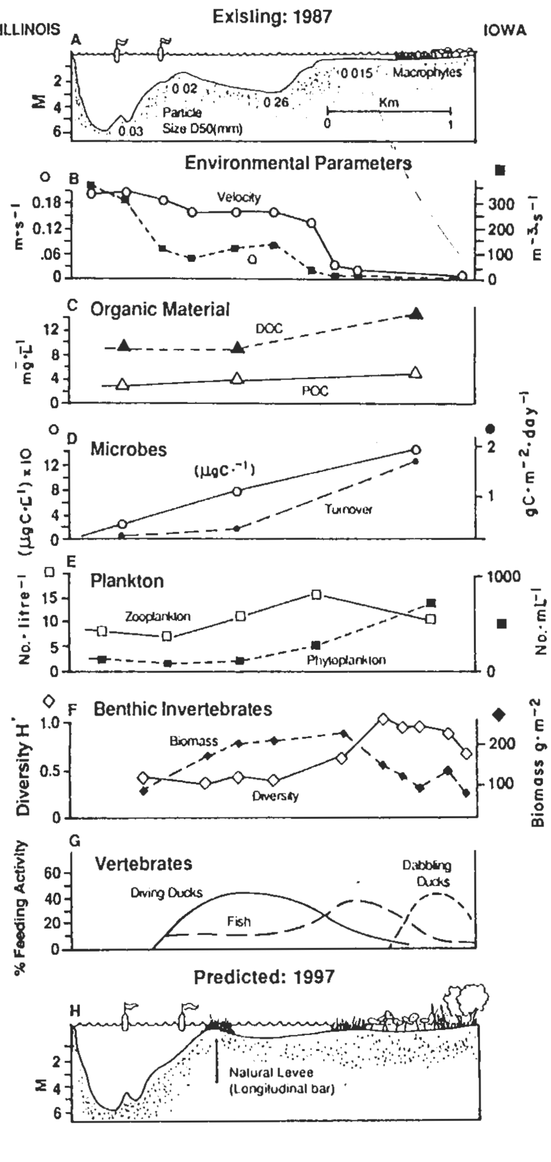

FIG. 3. A section of lower Keokuk Pool on the Upper Mississippi (A-G) with a projection of the stabilized system by the end of the century (H) (unpublished data from R. V. Anderson, R. E. Sparks, J. W. Grubaugh, K. S. Lubinski, and R. W. Gorden).

Even now, in an intermediate stage of succession in the Mississippi pools, the channel borders, not the main channel, are centers of production. Concentrations of particulate and dissolved organic carbon, plankton, and microbes are higher closer to the fringing plant beds and diminish toward the channel (Fig. 3C, E, and D). The greatest biomass of benthic macroinvertebrates are the burrowing filterers and collectors (mayflies of the genus *Hexagenia* and sphaeriid clams, *Musculium* and *Sphaerium*), which occur in beds just offshore of the macrophytes (Fig. 3F). These invertebrates apparently did not appear in high densities (up to 100 000 clams·m^{-2}) in the oldest pooled reach of the Mississippi R., the Keokuk Pool, until the 1960's (Gale 1969; Sandusky et al. 1979), when sedimentation raised the channel border bottom to the 1-m euphotic zone, thereby triggering autochthonous production by macrophytes. Diving ducks, which feed on concentrations of these invertebrates, only began using this pool in substantial numbers in the mid 1960's (Mills et al. 1966; Thompson 1973; F.C. Bellrose, pers. comm.). If phytoplankton or upstream sources had fueled the clams and mayflies, dense populations of these invertebrates should have been present in Keokuk Pool (but evidently were not) when Ellis (1931a, 1931b) made his biological surveys 18 years after the dam was closed, which was sufficient time for the accumulation of substrate suitable for burrowers. Organic matter was not being trapped behind upstream dams before it could enter the pool because these dams were not constructed until the late 1930's and early 1940's. The historical evidence from the Upper Mississippi R. thus supports the idea that a high level of secondary production requires a nearby center of primary production, rather than long-distance transport of organic matter from upstream sources via the main channel.

Conclusions

From a hydrological aspect, floodplains are part of the drainage system of rivers and are periodically affected by transport of water and dissolved and particulate material. From an ecological point of view, they represent transition zones (ATTZ) that alternate between aquatic and terrestrial states and link river channels with permanent lentic bodies and permanently dry land. Most large river systems have geomorphological settings that produce floodplains that are large relative to the lotic surface area (Welcomme 1985), and, in unmodified watersheds, produce a pulse of long duration that results in extensive but temporary lentic areas covering the ATTZ. Conversely, flood pulses of short duration, which are typical of low-order streams or of some modified systems, are associated with ATTZ's that are frequently covered by flowing water for short periods.

The flood pulse is the driving force for river–floodplain systems and maintains them in dynamic equilibrium. The system responds to the rate of rise and fall and to the amplitude, duration, frequency, and regularity of the pulses. Unpredictable pulses generally impede the adaptation of organisms and are counterproductive for many of them. Conversely, a regular pulse allows organisms to develop adaptations and strategies for efficient utilization of habitats and resources within the ATTZ, rather than depend solely on permanent water bodies or permanent terrestrial habitats. In temperate regions, the light and/or temperature regime may modify the biological effects of the pulse; timing of the pulse becomes important. In polar, sub-arctic, and taiga rivers where ice scouring occurs, the contribution to productivity from the ATTZ is not realized. In semiarid regions, local precipitation has a strong influence on the floodplain biota during the dry phase.

A variety of physical structures in combination with the flood pulse results in great habitat diversity. This diversity is coupled with the dynamic effect of the moving littoral, which extends the edge effect of the littoral over the entire ATTZ, thereby rendering channel banks bordering lotic zones insignificant by comparison. Organisms tend to invade the ATTZ from the terrestrial side also. Regular pulsing coupled with habitat diversity favors high diversity of aquatic and terrestrial plants and animals, despite considerable stress that results from the change between terrestrial and aquatic phases.

Aquatic and terrestrial productivity of river–floodplain systems depend mainly on the nutrient status of the water and sediments, on the climate, and on the flood pulse. Cycles specific to the floodplain, however, are decoupled to some extent from the nutrient status of the main channel. The moving littoral prevents permanent stagnation, thereby allowing the rapid recycling of organic matter and nutrients and resulting in a productivity that we predict to be greater than if the ATTZ were either permanently inundated or dry. Primary production associated with the ATTZ is much higher than that of permanent water bodies in unmodified systems and can often exceed that of permanent terrestrial habitats.

Transport of organic carbon from upstream catchment areas into the floodplain (spiralling) is of little importance to the productivity of the system. Conversely, primary and secondary production of the floodplains is essential to fauna in the main channels. A major component of energy transfer between floodplains and main channels is effected by animal migration, in particular of fish that also migrate upstream for considerable distances. Some bird species transfer nutrients from terrestrial areas or flooded mudflats, where they feed, to floodplain lakes, where they rest and defecate; other species do the reverse. The main function of the river channel in relation to plants and animals in the river–floodplain system is that of a migration route and dispersal system to access resources and refuges.

In conclusion, for those interested in the principal driving forces responsible for the structure, function, and evolutionary history of the biota in river–floodplain systems, we believe that the concept offered here will prove of heuristic rather than merely descriptive value. There is a fundamental dichotomy in the river–floodplain system: both continuous (e.g., the RCC) and batch processes occur. The latter, represented by the flood pulse concept, is dominant in systems with floodplains (ATTZs), in particular when the pulse is regular and of long duration. It is distinct because processes in floodplains do not depend on inefficient processing of organic matter upstream, although their inorganic nutrient pool may be replenished with periodic lateral inflows of water and sediments from the main channel. The pulse concept differs in that the position of the floodplain in the system relative to the river network is not a primary determinant of the processes that occur, although hydrological circumstances do not normally favor floodplain development in extreme upper reaches. However, examples do occur in upper reaches, such as the Pantanal of the Paraná system and the extensive Bolivian and Peruvian floodplains in the Amazon.

This concept implies an approach to studying the system different from the traditional limnological paradigms for either lotic or lentic systems. The space and time scales appropriate for understanding the mechanisms differ from those related to longitudinal processes in lotic channels. We hope that the flood pulse concept will help ecologists improve the design of studies and frame hypotheses that will lead more directly to a better understanding of river–floodplain systems. This is an urgent goal considering the modifications that continue to be proposed and that are sometimes put into practice in many tropical and temperate systems.

Acknowledgments

The following gave valuable suggestions: J.R. Adams, J. Adis, R.V. Anderson, C.F. Bryan, W.R. Edwards, R.W. Gorden, J.W. Grubaugh, M. Grubb, R.W. Larimore, L.L. Osborne, K. Robertson, S.K. Robinson, and M.J. Wiley. Amazon work was supported by CNPq, Brasilia and INPA of the Brazilian Government, and the Max-Planck-Institute for Limnology of West Germany. Research on the Upper Mississippi R. was supported by a National Science Foundation grant for long-term ecological research (LTER), No. BSR-8114563 and BSR-8612107, and by the loan of equipment from the Upper Mississippi River Basin Association.

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North American Journal of Fisheries Management 18:998–1003, 1998

Variation in Largemouth Bass Recruitment in Four Mainstream Impoundments of the Tennessee River

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Abstract.—Variation in recruitment of largemouth bass *Micropterus salmoides* was quantified in four mainstream impoundments along an 800-km segment of the Tennessee River and compared with various types of hydrologic and aquatic plant abundance data in an attempt to explain factors related to the formation of strong and weak year-classes. Residuals from four catch-curve regressions for age-2–11 fish collected in 1993 or 1994 were used to describe year-class strength. The formation of strong and weak year-classes was generally synchronous in these four reservoirs. Year-class strength was inversely related to average June–July discharge and positively associated with retention (reservoir volume/discharge) for data pooled from all reservoirs. Thus, weak year-classes were produced during wet early-summer conditions after largemouth bass hatched, whereas stronger year-classes were produced during dryer early-summer conditions. Late-summer aquatic plant abundance and water level fluctuations during April–May while spawning was occurring were not related to largemouth bass recruitment in these four reservoirs. We speculated that higher discharges and faster flushing rates were associated with reduced production at lower trophic levels and poorer survival of young largemouth bass that ultimately affected recruitment to adult size.

Largemouth bass *Micropterus salmoides* are a popular sport fish found throughout impoundments of the Tennessee River. Sustained recreational fishing for this species depends on adequate reproduction and recruitment to the fishery. For example, annual catch rates of largemouth bass varied more than twofold between 1990 and 1994 in Guntersville Lake on the Tennessee River, and catch rates were related to recruitment of strong year-classes (Wrenn et al. 1996).

Reservoir hydrology and aquatic macrophytes can influence largemouth bass recruitment (reviewed by Ploskey 1986; Wrenn et al. 1996). Typically, greater production of young largemouth bass was associated with high water levels in the spring and summer when largemouth bass spawn; young fish inhabit flooded areas, which provide habitat that can, thus, lead to higher survival rates (Ploskey 1986). Spawning time and availability of food resources also greatly influence largemouth bass reproductive success and survival to age 1 (Ludsin and DeVries 1997). The trophic state of reservoirs can also be used to predict young largemouth bass abundance (Hoyer and Canfield 1996). Disruptive weather and water levels can also negatively affect largemouth bass reproduction (Summerfelt 1975; Maceina and Isely 1986; Kohler et al. 1993).

Submersed aquatic macrophytes in reservoirs can provide cover and food resources for young largemouth bass and thereby increase recruitment to the fishery (Durocher et al. 1984; Bettoli et al. 1992; Wrenn et al. 1996). The introduction and spread of nonnative plants—primarily Eurasian milfoil *Myriophyllum spicatum* and, to a lesser extent, hydrilla *Hydrilla verticillata*—throughout the Tennessee Valley have been viewed by largemouth bass anglers as a benefit, but they have hindered other recreational activities and created conflicts among users (Henderson 1996). Many anglers believe that the increase in aquatic plants that occurred throughout the Tennessee River system in the 1980s was directly associated with an increase in largemouth bass and that it also provided habitat conducive to high catch rates.

In Kentucky Lake on the Tennessee River, electrofishing samples and angler catch rates of largemouth bass increased in the 1980s after initiation of a restrictive length limit (Buynak et al. 1991). However, the impact of this length limit on the fishery was confounded by drought conditions that increased the trophic state and fish production in this reservoir (Buynak et al. 1991). Thus, understanding factors associated with largemouth bass production and particularly recruitment is important to understand and manage these fisheries. In this paper, we present analyses of factors including

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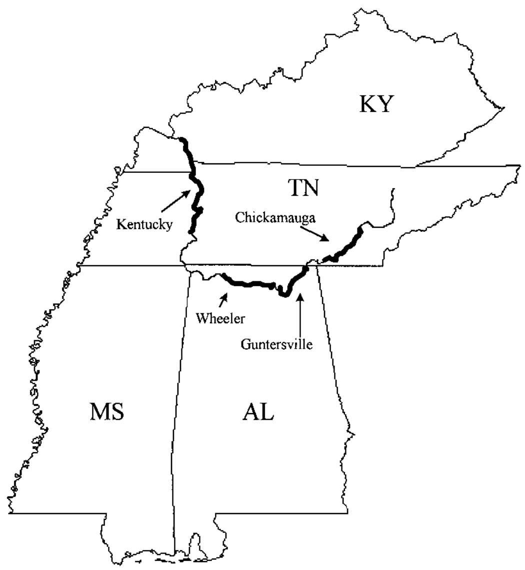

FIGURE 1.—Map of the Tennessee River with locations of Chickamauga, Guntersville, Wheeler, and Kentucky lakes.

reservoir hydrology and aquatic macrophytes that may be associated with largemouth bass recruitment in four impoundments in three states along 800 km of the mainstream Tennessee River.

Methods

An electrofishing catch depletion technique (Maceina et al. 1995b) was used in spring 1993 and 1994 to sample largemouth bass from Chickamauga, Guntersville, Wheeler, and Kentucky lakes (Figure 1). Twenty-three coves were sampled that ranged in size from 1.77 to 3.90 ha; total area sampled was 50.26 ha. Trophic state, based on chlorophyll-*a* concentration and mean depth, was similar among reservoirs (Table 1). However, long-term average retention (volume/discharge) and volume increased from upstream to downstream impoundments. Regulated water level fluctuations occurred on three systems, and plant abundance was highly variable among years and reservoirs; peak plant coverages were measured in the middle and late 1980s.

All fish were measured for total length (TL, in mm), and the age structure of the largemouth bass population was estimated by using otoliths from a subsample of 190 fish from Guntersville Lake (1993), 130 fish from Chickamauga Lake (1994), 110 fish from Wheeler Lake (1994), and 116 fish from Kentucky Lake (1994). Otolith preparation and examination followed the procedures of Hoyer et al. (1985) and Maceina (1988). Ages were assigned to unaged fish by using length–age keys for fish in 25-mm TL-groups. A total of 3,189 fish, ranging in age from 1 to 11 years, were collected from Chickamauga Lake (743 fish), Guntersville Lake (1,007 fish), Kentucky Lake (433 fish), and Wheeler Lake (503 fish). Of these, 1,481 age-2 and older fish were included in the analyses for the four reservoirs because we assumed these fish were fully recruited to our gear.

From age-structure data for each population, the residuals of catch-curve regressions were used as a quantitative index of variable recruitment (Maceina 1997). Equations were derived by regressing the natural log of absolute abundance of age-2 and older fish against age. The predicted natural log value from these catch-curve regressions was used to weight subsequent regressions by following the methods of Freund and Littell (1991). This procedure weighted the observations in the regression with smaller weights assigned to older, rarer fish, which reduced their contribution to the regression sum of squares and had the opposite effect for more abundant sample sizes. Regression equations were computed for each reservoir to predict abundance at age (y-variable), above that explained by age, with other independent parameters that we speculated were related to strong and weak year-class formation. The generalized weighted regression equation that included reservoir environmental terms (ENVIR) was (from Maceina 1997)

$$\log_e(\text{number}) = b_0 - b_1(\text{age}) \pm b_2(\text{ENVIR}).$$

TABLE 1.—Description of four mainstream reservoirs sampled on the Tennessee River in Kentucky, Tennessee, and Alabama.

Reservoir	Size (ha)	Mean depth (m)	Volume (ha-m)	Regulated fluctuation (m)	Average retention (d)	Chlorophyll *a* (mg/m^3)	Plant cover (%)	Jun–Jul retention (d)
Kentucky	64,870	5.4	350,298	1.5	23	14	1–4	13–117
Wheeler	27,150	4.9	133,030	1.8	11	8	3–15	6–32
Guntersville	27,500	4.5	123,750	<1	12	7	7-29	7–43
Chickamauga	14,330	5.5	78,815	2.3	8	8	1-21	6–26

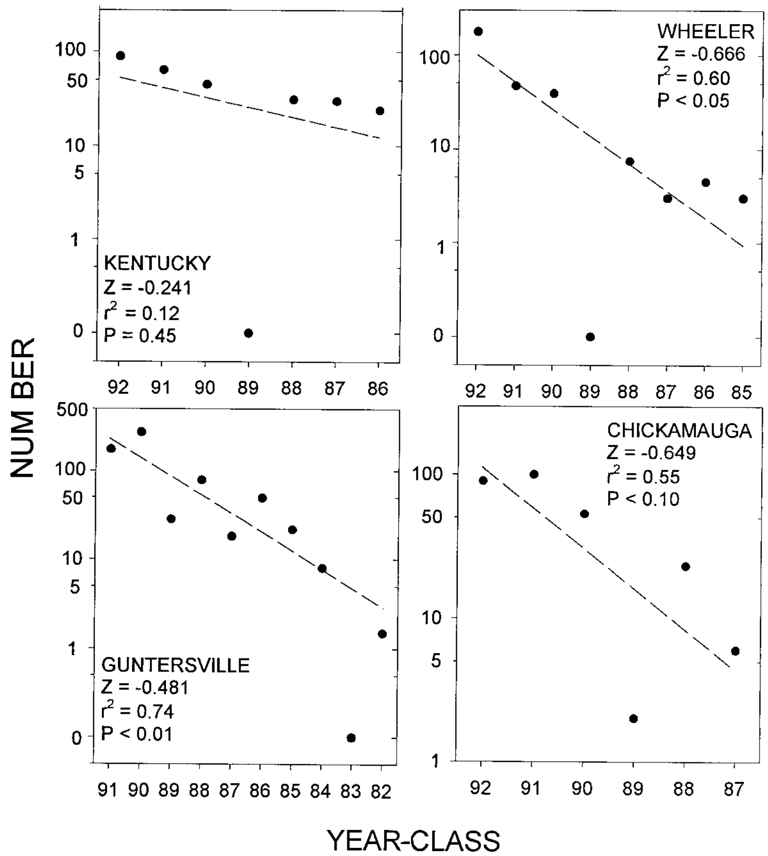

FIGURE 2.—Catch-curve plots and instantaneous mortality rates (Z) for four Tennessee River reservoirs.

Environmental terms included reservoir hydrologic characteristics and aquatic plant coverage. The equation included the intercept (b_0); b_1 and b_2 were the partial regression coefficients.

We explored a host of reservoir environmental terms that might be related to recruitment for data collected from 1 April to 31 December for age-0 fish in each year and reservoir by using the residuals derived from simple regression catch-curves that were weighted as previously described. Spawning in this region is initiated in April and extends through mid-June, based on daily ring counts from otoliths of age-0 fish collected from Guntersville Lake (Maceina et al. 1995a). Mean daily discharge rates were averaged each month, and from this, retention for each month was computed. Various seasonal averages for discharge and retention were computed and entered into equation (1) to derive best fits for each reservoir data set. Water levels were regulated more than 1 m in three reservoirs (Table 1) and typically increased each year from 1 April to 31 May; and the maximum absolute change in stage during this time period on year-class formation was examined. After 1 June, reservoirs were typically maintained at full pool until the fall months. Plant coverage was estimated annually in each reservoir during late summer by using color photography and onsite mapping procedures part of the Tennessee Valley Authority (TVA) monitoring program (D. Webb; TVA; unpublished data). The relation between residuals, discharge, and retention was also described using correlation, regression, and nonlinear regression (Freund and Littell 1991). Although we used the residuals or error associated with catch-curves as an indicator of year-class strength, measurement error can occur with these values.

Results and Discussion

The 1989 year-class of largemouth bass was weak and nearly undetectable in these four reservoirs, whereas the 1986, 1988, and 1990 year-classes were relatively abundant (Figure 2). Year-class formation was generally consistent in Ken-

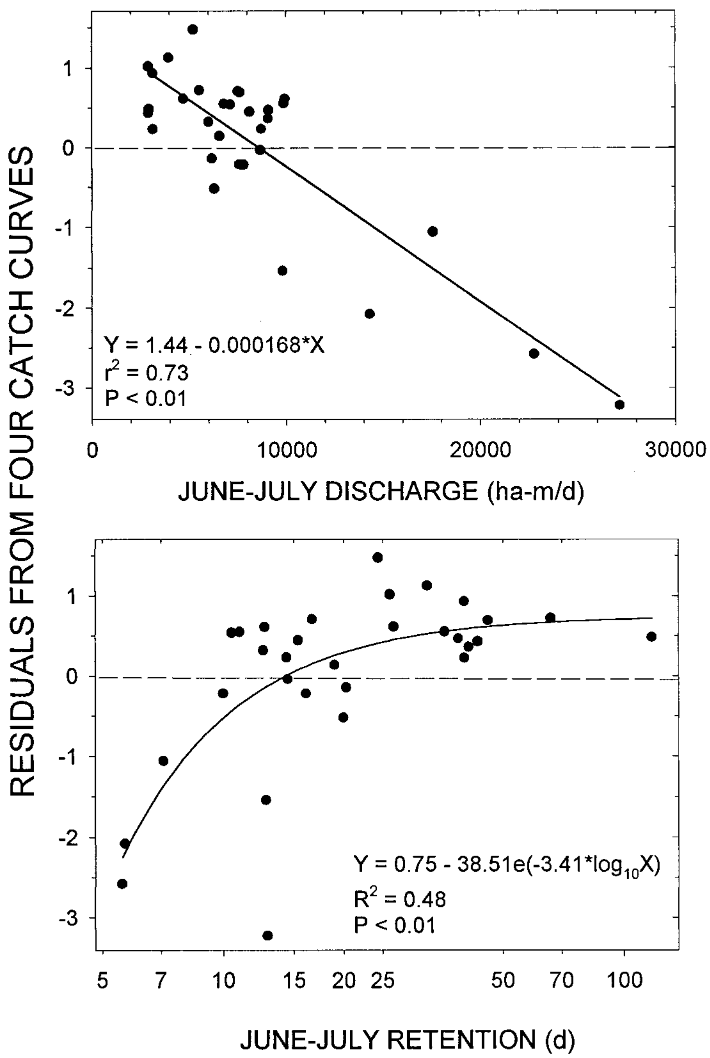

FIGURE 3.—Residuals computed from four catch-curve regressions from each reservoir plotted against average June–July discharge (top) and average June–July retention (bottom).

tucky Lake except for the absent 1989 year-class, which caused the relation between age and abundance at age to be statistically nonsignificant ($P > 0.10$). In all reservoirs, mean daily discharge from 1 June to 31 July was a significant ($P < 0.05$) negative regressor when added to the simple catch-curve regression, and it improved the fit for predicting abundance at age from age. This was particularly obvious in Kentucky Lake, where the age term became a significant ($P < 0.05$) regressor of abundance after accounting for the effects of discharge. Among the four regressions computed for each reservoir, discharge explained an additional 11–83% (squared semipartial correlation coefficients) of the variation in number at age after accounting for the effects of age.

Daily discharge from 1 June to 31 July when fish were age 0 was inversely related to residuals pooled from the four reservoirs, and this variable explained 73% of the variation in largemouth bass year-class strength (Figure 3). Nonlinear relations were examined between these two variables, but the linear fit was best. Thus, stronger year-classes occurred when inflows were low, and the probability of increased year-class strength occurred when daily discharges during this time were less than 7,000 ha-m/d (Figure 3). Weak year-class formation was typically evident when discharges were higher during early summer.

The relation between June–July retention and residuals was positive and asymptotic; above average year-class strength was predicted at retentions of 15 d and longer (Figure 3). About 48% of the variability in year-class strength was explained by retention. Discharge and retention covaried, but the relation was nonlinear and discharge only explained 46% of the variation in retention. Because volume varied about fourfold among reservoirs (Table 1), retention more accurately described flushing rate, which ultimately affects phytoplankton production (Soballe and Kimmel 1987; Maceina et al. 1996) that cascades up the food chain into higher trophic levels (McQueen et al. 1986). Thus, longer retention during dryer climatic conditions probably increased young largemouth bass production.

For reservoir data analyzed separately or pooled, correlative and multiple-regression analyses revealed that neither late-summer plant coverage nor the change in water level from 1 April to 31 May was related ($P > 0.20$) to the formation of strong and weak year-classes in these four Tennessee River impoundments.

We found that largemouth bass recruitment was synchronous and related to reservoir discharge along an 800-km stretch of the Tennessee River that encompassed four mainstream impoundments. Slipke et al. (1998) found a similar pattern of strong and weak year-classes for smallmouth bass *M. dolomieu* on Pickwick Lake, a mainstream impoundment of the Tennessee River directly upstream from Kentucky Lake. Greater recruitment of smallmouth bass occurred when average daily discharges were less than 8,000 ha-m/d from April to July during the spawning and early postspawning period, whereas poor year-class formation was observed when daily discharges averaged greater than 12,000 ha-m/d (Slipke et al. 1998). These patterns of year-class formation and discharge levels for largemouth bass and smallmouth bass indicated that characteristics of year-class production in black bass may not be species-specific in the Tennessee River.

Although we detected no relation between largemouth bass reproductive success and submersed aquatic plant cover, Wrenn et al. (1996) found that age-1 largemouth bass abundance was greater in vegetated than in unvegetated habitats in 1991, when summer retention was low. Hence, when wet climatic conditions occur and reservoir retention is low, aquatic plants may enhance age-1 recruitment. Webb et al. (1995) observed that submersed aquatic plant abundance was inversely related to discharge in Guntersville Lake. Thus, our results that showed a negative relation between largemouth bass recruitment and early summer discharge may be a spurious correlation. However, Wrenn et al. (1996) found low and high densities of age-0 largemouth bass in Guntersville Lake from 1990 to 1994 even though plant abundance was low during all years. In addition, plant cover was not related to the occurrence of strong and weak year-classes in any reservoir or for all the data pooled in our study. Finally, Buynak et al. (1991) found largemouth bass abundance increased in both Kentucky Lake and Barkley Lake (Cumberland River in Kentucky) during periods of low discharge even though submersed plants were abundant in Kentucky Lake but rare in Barkley Lake.

Our results support the observations of Buynak et al. (1991), who found greater largemouth bass abundance in Kentucky Lake in the middle and late 1980s coincided with drought conditions, longer retention, and higher planktonic primary productivity. Largemouth bass are better adapted to lentic than to lotic conditions (Stuber et al. 1982), and impoundment of the Tennessee River created a fluctuating gradient between riverine and natural lake conditions. Thus, largemouth bass recruitment appeared higher when mainstream Tennessee River impoundments were more lentic. Phytoplankton increases with longer retention time in reservoirs (Soballe and Kimmel 1987; Maceina et al. 1996), which undoubtedly affects food sources for largemouth bass. High inflow causes lower retention and increases reservoir turbidity (Soballe and Kimmel 1987), which may also reduce juvenile largemouth bass survival. Although climatic conditions regulating largemouth bass year-class formation are unmanageable, understanding this variation will assist fishery biologists in adjusting angler expectations, particularly when fishing success for largemouth bass is poor.

Acknowledgments

Field sampling was conducted by personnel from the Tennessee Valley Authority and coordinated by D. Lowery; F. Fiss assisted in laboratory analysis. Funding was provided by the Tennessee Valley Authority to M.J.M. and P.W.B. to conduct this analyses. This paper represents Journal 8-985923 of the Alabama Agricultural Experiment Station.

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Received February 2, 1998
Accepted May 31, 1998

North American Journal of Fisheries Management 20:791–800, 2000

Population Dynamics of a Reservoir Sport Fish Community in Response to Hydrology

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Abstract.—Sport fish from Normandy Reservoir, Tennessee, were sampled for more than 6 years with a variety of gears targeting different life stages. Normandy Reservoir experienced different hydrologic regimes over the sampling period that we roughly grouped into dry years (1992 and 1995), intermediate years (1993 and 1997), and wet years (1994 and 1996). Year-class strength of largemouth bass *Micropterus salmoides* was fixed each year by late summer or early fall. Catch of age-1 largemouth bass in spring electrofishing samples was directly related to the number of days the reservoir was at or over full pool when the fish were age 0. Largemouth bass produced in a wet year and intermediate year were more than twice as abundant at age 3 than fish produced in two dry years. Recruitment of spotted bass *M. punctulatus* could not be linked to reservoir hydrology. Crappies *Pomoxis* spp., white bass *Morone chrysops,* and saugeyes (walleye *Stizostedion vitreum* × sauger *S. canadense*) produced poor year-classes in dry years and strong year-classes in wet years. The responses of these latter three taxa in intermediate years were variable, although they were more characteristic of dry-year responses than wet-year responses. Recruitment of crappies, white bass, and saugeyes was positively related to mean daily discharge of the reservoir in the prespawn period (1 January to 31 March) each year. Recruitment of largemouth bass was dependent on high water during the spring and summer when fish were age 0. Water-level fluctuation in this Tennessee reservoir played a pivotal role in regulating year-class strength of most sport fish species. Attempts to enhance year-class strength of fishes in tributary storage impoundments should focus on altering the hydrology of systems.

Identifying mechanisms regulating recruitment and year-class strength is a prerequisite to successful fisheries management in any system, and these issues have come to the forefront of basic reservoir research in recent years. Methods of predicting effects of changes in reservoir operations on fish populations need to be addressed because modifying reservoir operations is one of the few options available to fishery managers trying to enhance a fishery. Water-level fluctuations, readily observed characteristics separating reservoirs from natural lakes, are the result of meeting the primary objectives of reservoir operation: hydropower generation, water supply, and flood control. High spring water levels in a variety of systems have effected strong year-classes in many fish species: walleye *Stizostedion vitreum* in Michigan (Jude 1992); walleye and yellow perch *Perca flavescens* in Minnesota (Kallemeyn 1987); and yellow perch, white bass *Morone chrysops*, and buffalo *Ictiobus* spp. in South Dakota (Martin et al. 1981). Spring flooding has been linked to enhanced year-class strength of largemouth bass *Micropterus salmoides* in other reservoirs (e.g., Aggus and Elliot 1975; Martin et al. 1981; Miranda et al. 1984; Noble 1986; Reinert et al. 1997). Some reservoirs are managed for spring flooding and above-average summer pools to provide more habitat for age-0 black bass *Micropterus* spp., based upon empirical evidence that the abundance of larger black bass usually increases in the following year (Ploskey et al. 1996). First-year growth and weekly survival of age-0 largemouth bass in Normandy Reservoir were related to reservoir hydrology (Sammons et al. 1999). Wet years produced large cohorts that hatched early, grew fast, and survived well; dry years produced small cohorts that hatched late, grew slower, and survived poorly. Management strategies usually assume that greater abundance of age-0 fish will increase recruitment into the fishery, but this view may be too simplistic. Empirical relations between year-class strength and hydrology are critical for proper management and can enhance the bargaining position of fish managers negotiating with water-resources managers. Effects of water-level manipulation are not documented sufficiently and still cannot be predicted with any degree of confidence (Miranda et al. 1984).

Our objectives were to (1) quantify relationships

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[2] The Unit is supported by the U. S. Geological Survey, Tennessee Technological University, and Tennessee Wildlife Resources Agency.

Received June 30, 1999; accepted March 2, 2000

between water-level fluctuations and recruitment of sport fish populations in Normandy Reservoir, Tennessee, and (2) identify the critical period of recruitment to the fishery for black crappies *P. nigromaculatus* and white crappies *P. annularis* (hereafter ''crappies''), largemouth bass and spotted bass *M. punctulatus* (hereafter ''black bass''), white bass, and saugeyes (walleye × sauger *S. canadense).* Saugeyes were included in this study when they were found to be reproducing naturally in the reservoir (Fiss et al. 1997).

TABLE 1.—Hydraulic data for Normandy Reservoir over the course of the study. Data included first day of the year the reservoir achieved consistent (>10 d) full pool, number of days reservoir was at or over full pool during the spring and summer (Spring–summer DOFP), and mean daily discharge of Normandy Dam in the prespawn period (1 January to 31 March).

Year	First day of year at full pool	Spring–summer DOFP (d)	Prespawn mean discharge (m^3/s)
1991	120	78	27.6
1992	178	31	12.0
1993	116	68	11.7
1994	98	92	29.0
1995	129	40	10.0
1996	117	95	17.0
1997	124	80	24.0

Methods

Each spring from 1992 to 1997, samples of larval crappies, white bass, and saugeyes in Normandy Reservoir (Sammons et al. 1999 describes this reservoir) were collected weekly to compare larval densities with measures of recruitment to the fishery (Sammons and Bettoli 1998a). We compared geometric mean density among years by using repeated measures analysis of variance (ANOVA) procedures (Maceina et al. 1994; SAS Institute 1995). Statistical significance for tests in the study was set at $\alpha = 0.05$, or at $\alpha = 0.10$ when $N \leq 5$.

Age-0 black bass were collected with a DC electrofishing unit and a hand-held anode (as described in Sammons et al. 1999); 24 stations (6 stations in each of 4 areas) were electrofished biweekly between July and September from 1992 to 1997. Black bass were also sampled in the spring (March–April) and fall (October–November) each year with a DC electrofishing boat equipped with boom-mounted electrodes. Each season we collected black bass at night from 40 randomly selected 100-m transects stratified by lake area and habitat (Sammons and Bettoli 1999). All black bass collected were sacrificed and their otoliths were removed. All electrofishing catch data (number of fish/100 m) were $\log_{10}(X + 1)$ transformed before analysis. Catch rates of different year-classes were calculated for each sample. We ranked the catch of each cohort over time in different gears to determine when year-class strength of black bass was fixed in Normandy Reservoir (Forney 1976). Comparisons of catch among years were made using ANOVA; differences in catch among years were tested using Tukey's Studentized range procedures.

Recruitment of crappies to the fishery was assessed in August cove samples at three sites, totaling 2.11 ha, where rotenone was applied following standard methods (Bettoli and Maceina 1996). Recruitment of white bass and saugeyes to the fishery was assessed using catch of age-1 fish in horizontal gill nets set lakewide in early October. Nets were deployed at 11 fixed stations each year. We used sinking experimental monofilament gill nets (46.9 m long × 1.8 m deep; six mesh sizes 19, 25, 38, 51, 64, and 76 mm). Catch data were $\log_{10}$ transformed and compared among years using ANOVA and Tukey's Studentized range procedure (SAS Institute 1995).

All fish from boom-mounted electrofishing, cove samples, and gill-net samples were measured to the nearest millimeter total length (TL) and aged using right sagittal otoliths examined under a dissecting microscope in whole view. We verified ages of fish that appeared to be age 3 and older by cracking the left otolith in half through the focus, polishing the broken edge, mounting it under water, and using a fiber-optic strand (0.5-mm diameter) to illuminate annuli.

All water-level and discharge data were obtained from Tennessee Valley Authority. Water levels were recorded at the dam at midnight. Relations between the measures of recruitment for each species and hydraulic data were tested using simple linear regression (SAS Institute 1995).

Results

Hydrology

Water-level patterns in Normandy Reservoir were described by Sammons et al. (1999) and followed three distinct patterns during the study: dry, intermediate, and wet. Water levels in two dry years (1992 and 1995) were slow to reach full pool, and spring and summer reservoir water levels remained at or above full pool only briefly (≤40 d). In three intermediate years (1991, 1993, 1997), the reservoir reached full pool in late April (Table 1),

TABLE 2.—Geometric mean catch in electrofishing samples of six year-classes (1992–1997) of largemouth bass and spotted bass at intervals during their first year of life in Normandy Reservoir, Tennessee. Values in brackets are ranks; values in parentheses are upper and lower 95% confidence intervals.

Year-class	Geometric mean catch (fish/100 m)			
	Hand-held probe		Boom-mounted probes	
	Early Aug	Late Sep	Fall (age 0)	Spring (age 1)
	Largemouth bass			
1992	1.70 [3]	0.70 [5]	0.15 [5]	0.19 [5]
	(0.97, 2.61)	(0.28, 1.24)	(0.02, 0.29)	(0.03, 0.37)
1993	4.81 [1]	0.95 [3]	0.43 [3]	0.60 [4]
	(3.44, 6.60)	(0.54, 1.46)	(0.23, 0.68)	(0.33, 0.91)
1994	2.50 [2]	1.54 [2]	1.20 [1]	1.74 [2]
	(1.62, 3.79)	(1.07, 2.14)	(0.71, 1.83)	(1.23, 2.38)
1995	1.62 [5]	0.42 [6]	0.09 [6]	0.16 [6]
	(0.84, 2.70)	(0.14, 0.73)	(0.00, 0.19)	(0.03, 0.32)
1996	1.69 [4]	0.79 [4]	0.35 [4]	1.83 [1]
	(0.97, 2.68)	(0.40, 1.23)	(0.17, 0.56)	(1.22, 2.60)
1997	1.29 [69]	1.93 [1]	0.67 [2]	0.71 [3]
	(0.69, 2.10)	(1.24, 2.83)	(0.42, 0.96)	(0.42, 1.07)
	Spotted bass			
1992	0.52 [5]	0.58 [4.5]	0.57 [2]	0.85 [1]
	(0.26, 0.85)	(0.27, 0.98)	(0.32, 0.85)	(0.45, 1.37)
1993	0.11 [6]	0.06 [6]	0.56 [3]	0.71 [2]
	(0.00, 0.25)	(0.00, 0.19)	(0.33, 0.85)	(0.44, 1.02)
1994	1.20 [2]	1.44 [2]	1.45 [1]	0.53 [4]
	(0.64, 1.96)	(0.78, 2.34)	(0.97, 2.03)	(0.28, 0.83)
1995	0.64 [4]	2.52 [1]	0.43 [5]	0.33 [6]
	(0.26, 1.16)	(1.66, 3.66)	(0.25, 0.63)	(0.14, 0.54)
1996	1.44 [1]	1.11 [3]	0.44 [4]	0.65 [3]
	(0.75, 2.40)	(0.58, 1.83)	(0.22, 0.69)	(0.34, 1.03)
1997	0.88 [3]	0.58 [4.5]	0.35 [6]	0.51 [5]
	(0.52, 1.32)	(0.22, 1.05)	(0.18, 0.55)	(0.25, 0.82)

and spring and summer water levels remained at or above full pool for more than 60 d before falling below full pool in July. In two wet years (1994 and 1996), reservoir levels remained over full pool throughout much of the summer (>90 consecutive days; Table 1). In 1994, the reservoir exceeded full pool on March 25, and again on April 7; whereas, in 1996 the reservoir reached full pool on April 26. Mean daily discharge during the prespawn period (1 January–31 March) was highest in 1991, 1994, 1997, and 1996, indicating that these years were characterized by high precipitation.

Black Bass

Repeated measures ANOVA, which compared electrofishing catch rates throughout the summer each year, revealed annual differences in the density of age-0 largemouth bass (F = 9.42; df = 5, 710; P = 0.0001). Mean summer densities of age-0 largemouth bass were highest in 1993; slightly lower in 1994 and 1997; and similarly low in 1992, 1995, and 1996. Age-0 spotted bass summer densities also differed among years (F = 9.33; df = 5, 650; P = 0.0001); mean summer densities were highest in 1994 and 1996 and lowest in 1993.

There was often no relation between abundance of age-0 largemouth bass in midsummer (peak abundance) and abundance in late summer (Table 2); for instance, the most abundant year-class in early August samples (1993) was the third most abundant in late September samples. However, the abundance ranking of each largemouth bass cohort in late summer was similar to their rank in fall and spring electrofishing samples (Table 2), except for 1996, when abnormally high water levels in the fall decreased our sampling efficiency. Spotted bass showed no relationship among abundance ranks in any of the four time intervals examined for largemouth bass (Table 2).

Abundance of largemouth bass as age-1 fish in spring electrofishing samples was used as a measure of recruitment for each year-class; abundance varied almost an order of magnitude over 6 years (F = 17.69; df = 5, 234; P = 0.0001; Table 3). Spotted bass cohorts did not differ in abundance

TABLE 3.—Measures of recruitment for various fish species in Normandy Reservoir, Tennessee. Gear types are as follows: spring electrofishing (EF), mean density in cove samples (CR), and mean catch in horizontal gill nets (GN). Geometric means within species with a letter in common did not significantly differ (Tukey's test, $\alpha = 0.05$).

Species	Gear and unit	Year-classes 1991	1992	1993	1994	1995	1996	1997
Largemouth bass	EF (age-1 fish/100 m)		0.19 yz	0.58 yz	1.74 x	0.16 z	1.83 x	0.71 y
Spotted bass	EF (age-1 fish/100 m)		0.85 z	0.71 z	0.53 z	0.33 z	0.65 z	0.51 z
Crappies	CR (age-1 fish/ha)	97 y	0 z	1 z	1,358 x	0 z	35 y	
White bass	GN (age-1 fish/net night)	2.52 y	0.06 z	0.21 z	2.10 yz	0 z	0.81 yz	
Saugeye	GN (age-1 fish/net night)	0.57 z	0 z	0.06 z	2.84 y	0.06 z	0.21 z	

in any year ($F = 1.42$; df = 5, 234; $P = 0.2184$). Catch of age-1 largemouth bass was positively correlated with the number of days that Normandy Reservoir was over full pool when that cohort was age 0 (Figure 1). No such correlation existed for spotted bass.

Largemouth bass hatched in a high-water year (1994) and an intermediate year (1993) were more abundant as age-3 fish in spring electrofishing samples than cohorts produced in dry years (1992, 1995; Table 4). Sampling was terminated before the abundance of age-3 largemouth bass produced in 1996 and 1997 (wet and intermediate) was measured. Abundance of age-3 spotted bass was similar for all year-classes, regardless of reservoir hydrology when the cohort was age 0.

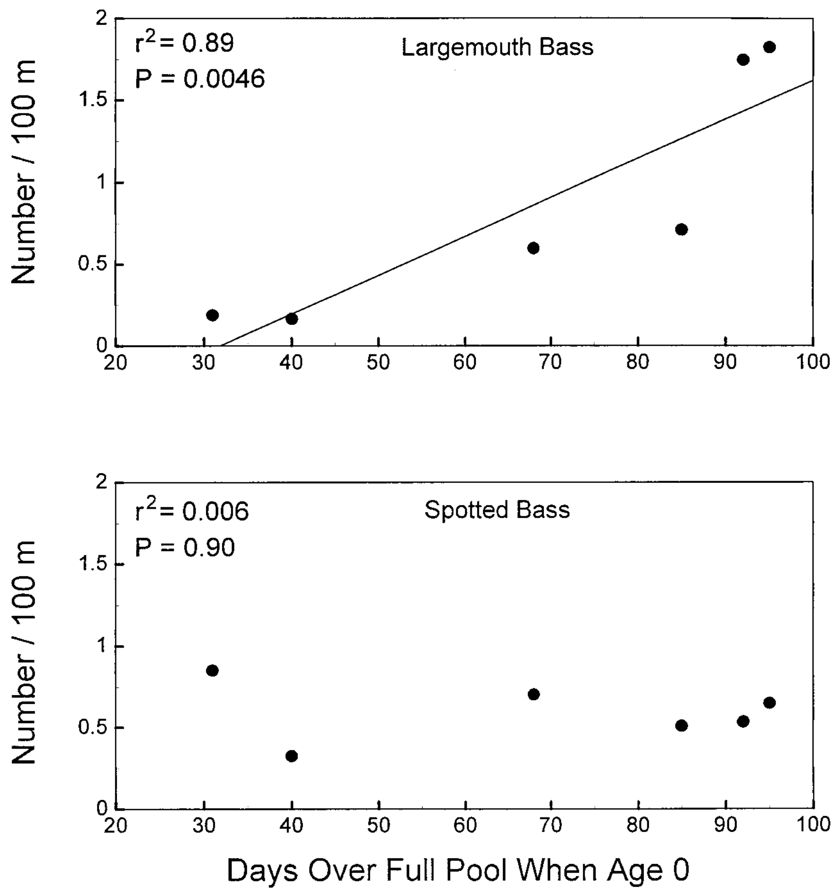

FIGURE 1.—Relations between catch of age-1 largemouth bass and spotted bass in spring electrofishing samples and number of spring and summer days, when the fish were age 0, that Normandy Reservoir was over full pool.

TABLE 4.—Geometric mean catch (95% confidence intervals) of age-3 largemouth bass (F = 4.91; df = 4, 156; P = 0.0028) and spotted bass (F = 1.18; df = 3, 156; P = 0.3202) produced in a wet year, an intermediate year, and two dry years in Normandy Reservoir, Tennessee. Means in columns with a letter in common did not significantly differ (Tukey's test, α = 0.05).

Year-class	Hydrology	Geometric mean catch (fish/100 m) Largemouth bass	Spotted bass
1992	Dry	0.169 z (0.052, 0.298)	0.509 z (0.314, 0.734)
1993	Intermediate	0.360 yz (0.163, 0.590)	0.244 z (0.097, 0.410)
1994	Wet	0.645 y (0.358, 0.994)	0.364 z (0.157, 0.607)
1995	Dry	0.189 z (0.080, 0.309)	0.406 z (0.198, 0.650)

Crappies, White Bass, and Saugeyes

Catch of age-1 crappies (mean 113 mm TL, range 70–256 mm) in cove samples differed among years (F = 38.15; df = 5, 12; P = 0.0001). Mean catch of age-1 crappies was highest for the 1994 year-class, intermediate for the 1991 and 1996 year-classes, and low for other year-classes (Table 3). Catch of age-1 crappies in cove samples was positively related to mean daily reservoir discharge from 1 January to 31 March in the year each year-class was produced (Figure 2).

Catch of age-1 white bass (mean 325 mm TL, range 254–394 mm) in gill nets differed among years (F = 7.48; df = 5, 60; P = 0.0001). Catch of the 1991 year-class was highest, followed by the 1994 and 1996 year-classes (Table 3). Catch in all other years was similar and low (Table 3). Peak larval catch of white bass was correlated with catch of age-1 fish in gill nets (r^2 = 0.66; N = 5; df = 1, 3; P = 0.0953). Catch of age-1 white bass in fall gill-net samples was positively related to mean daily reservoir discharge from 1 January to 31 March in the year each year-class was produced (Figure 2).

Catch of age-1 saugeyes (mean 419 mm TL, range 251–479 mm) in gill-net samples also differed among years (F = 14.20; df = 5, 60; P = 0.0001). Catch of the 1994 year-class was higher than any other year-class (Table 3). Catches of the 1991 and 1996 year-classes were 4–10 fold higher than the next highest year-class but were not significantly different (Table 3). Similar to white bass and crappies, catch of age-1 saugeyes in fall gill-net samples was positively related to mean daily reservoir discharge from 1 January to 31 March in the year each year-class was produced (Figure 2).

Discussion

Black Bass

In Normandy Reservoir, largemouth bass year-class strength was fixed late in the year and was dependent on the amount of water the system held throughout the summer. When water levels dropped in late summer, largemouth bass experienced reduced survival and abundance (Sammons et al. 1999). Reinert et al. (1997) also noted that a decrease in surface area of four southeastern reservoirs was linked to decreased abundance of age-0 black bass. Similar to our findings in Normandy Reservoir, Jackson et al. (1991) documented high mortality of age-0 largemouth bass in summers when water levels fell below the conservation pool in Lake Jordon, North Carolina. Decreasing water levels reduce shoreline cover available to age-0 black bass, exposing them to increased rates of predation and reducing their feeding efficiency (Aggus and Elliot 1975; Irwin et al. 1997).

High water levels in Normandy Reservoir increased the numbers of harvestable largemouth bass in the fishery. When fish were age 3, largemouth bass produced in a wet year were still more than twice as abundant as fish produced in either a dry or intermediate year. These increases fell within the range of those predicted or observed by other authors (Gutreuter and Anderson 1985; Novinger 1988). High-water years in Normandy Reservoir produced cohorts of largemouth bass characterized by bimodal length distributions and fast growth (Sammons et al. 1999), which allowed the fish to reach harvestable sizes (minimum length limit is 381 mm in Normandy Reservoir) faster than other cohorts. Largemouth bass in the upper length mode of both the 1994 and 1996 year-classes were 18–52% larger than fish in the 1992 or 1993 year-classes at similar life stages (Sammons and Bettoli 1998b).

Unlike largemouth bass, spotted bass recruitment was similar over all 6 years. Little work has been published on spotted bass ecology in reservoirs; however, either our gear did not sample them effectively or spotted bass recruitment was unaffected by reservoir water levels. Ploskey et al. (1996) found that biomass of small spotted bass in Bull Shoals Reservoir, Arkansas, was correlated with flooding during the spawning, postspawning, and summer periods. However, biomass of small spotted bass was not well correlated with abundance of the next-year's intermediate-sized spotted bass in that system (r^2 = 0.30; P = 0.01; Ploskey et al. 1996), making the effect of hydrology on

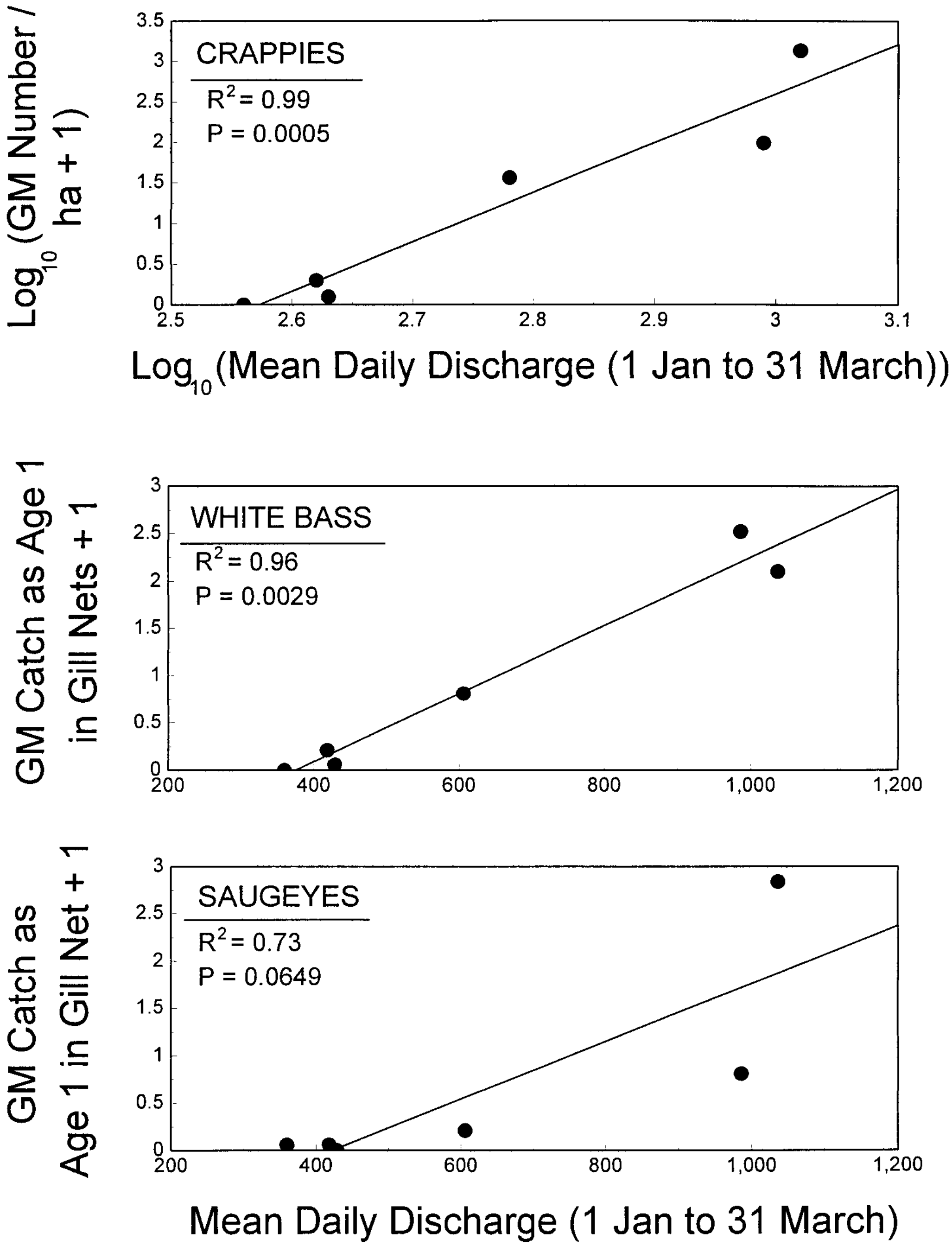

FIGURE 2.—Relations between geometric mean (GM) catches of crappies (top panel), white bass (middle), and saugeyes (bottom) to mean daily discharge from Normandy Reservoir, Tennessee, between 1 January to 31 March in the year each year-class was produced from 1992 to 1997.

recruitment to the fishery difficult to isolate. Abundance of age-0 spotted bass was greater with an increase in reservoir surface area during spring and summer in three of four southeastern reservoirs examined by Reinert et al. (1997).

Crappies

In Normandy Reservoir, the only strong year-classes of crappies produced during this study were in 1991, 1994, and 1996, which corresponded with high discharge levels early in the year. Catches of larval crappies were correlated with catch of the same year-class as age-1 fish in cove samples the following summer (Sammons and Bettoli 1998a), indicating that the critical period of these species was at or before the larval stage.

In reservoirs, water-level fluctuations are probably an important environmental variable determining crappie year-class strength (Willis 1986); however, the timing is different than that required for strong year-classes of largemouth bass. Groen and Schroeder (1978) and McDonough and Buchanan (1991) found that rising spring water levels increased relative abundance of white crappies. Similar to our data from Normandy Reservoir, Maceina and Stimpert (1998) noted that high water in late winter-early spring was required for crappies to reproduce successfully in Alabama tributary storage impoundments. They believed that high flows in these reservoir early in the year were a spawning cue for crappies, even in cases when the flow happened many weeks before the fish actually spawned. In Normandy Reservoir, strong year-classes of crappies were produced in years when mean daily discharge was more than 15 m^3/s in the prespawn period. In contrast, weak year-classes were produced when mean daily discharge in the prespawn period was under 15 m^3/s.

White Bass and Saugeyes

Effects of reservoir hydrology on fish species other than black bass and crappies are not well-known. In particular, little has been published in the primary literature about factors affecting white bass recruitment. As in Normandy Reservoir, white bass exhibit great variations in year-class strength in other systems (Yellayi and Kilambi 1976; Staggs and Otis 1996). In two South Dakota natural lakes, age-0 white bass abundance was correlated with spring precipitation and air temperature (Pope et al. 1997). Age-0 white bass were more abundant in Lake Francis Case, South Dakota, in a high-water year than a low-water year (Martin et al. 1981); however, precise measurements of year-class strength or hydrology were not given. In Normandy Reservoir, strong year-classes of white bass were produced in 1991, 1994, and 1996, and some reproduction occurred in 1993. Similar to crappies, high discharge levels in the prespawn period may have acted as a spawning cue for white bass; however, their reproduction may be less keyed to high discharge events than crappies because at least some fish spawned in 1993, when mean daily discharge was low (11.7 m^3/s). However, similar to crappies, discharge levels had to be more than 15 m^3/s if white bass were to produce a large year-class in Normandy Reservoir. Catch rates of larval white bass were correlated with gill-net catches of age-0 (Sammons and Bettoli 1998a) and subsequently age-1 fish. Therefore, it appears the critical period for this species is at or before spawning, similar to crappies.

Saugeyes, similarly, have not been extensively studied. Because natural recruitment of this stocked hybrid is usually an unwelcome surprise to fisheries managers, little research has been conducted to determine factors controlling such recruitment. However, high water has been linked to walleye spawning success in a number of systems (e.g., Kallemeyn 1987; Willis and Stephen 1987; Jude 1992). Walleye year-class strength in two Kansas reservoirs showed a domed response to spring storage ratios. Year-class strength was weak in years with high discharge, strongest at intermediate discharge, and virtually nonexistent in dry years (Willis and Stephen 1987). High water apparently decreased survival of juvenile fish to the point that recruitment was nil. However, similar to Normandy Reservoir, walleye recruitment was poor in dry years. Johnston et al. (1995) found that larval abundance of walleyes in a tributary of Dauphin Lake, Manitoba, was correlated to river discharge 35 d before median larval drift date. They speculated that adult walleyes coming upstream from the lake used high flows as a spawning cue. Although our larval sampling program began too late in the year to effectively sample saugeye larvae, large numbers of saugeye larvae were collected only in the year with the highest prespawn discharge levels (1994; Sammons and Bettoli 1998b) and the highest catch of age-1 fish in gill nets. It appeared that the critical period of saugeyes, similar to crappies and white bass, occurred at or before the larval stage.

Management Implications

Reservoir hydrology can play a pivotal role in fish recruitment. Not surprisingly, environmental requirements for successful spawning differ among species. Our results define the combination of hydraulic factors (reaching full pool early in spring; maintaining full pool for at least 90 d) that allow largemouth bass in Normandy Reservoir to produce strong year-classes. High water produced an expanded littoral habitat for age-0 largemouth bass, allowing them to experience rapid growth and survival (Sammons et al. 1999), which ultimately resulted in strong year-classes. Production of fast-growing largemouth bass ultimately resulted in more than twice as many adult bass recruiting to the fishery; many of those individuals reached harvestable size faster than cohorts spawned in other years. However, high water in the summer was of less benefit to other species, such as crappies, white bass, and saugeyes, all of which have limnetic larvae. The combination of hydraulic factors necessary for these species to produce strong year-classes was quite different from largemouth bass. Recruitment success for these species appeared to be linked to high discharge levels early in the year (mean of at least 15 $m^3 \cdot s^{-1} \cdot d^{-1}$ between 1 January and 31 March), before the spawning periods, and was probably a spawning cue for adults. Unlike largemouth bass, once the adults of these species spawned successfully, strong year-classes were assured. Management to improve crappie, white bass, and saugeye recruitment can be compatible with management for largemouth bass for two reasons. First, a strong serial correlation usually exists between hydrologic conditions in early spring, spring, and early summer. Conditions that produce high discharge in early spring usually produce above-average water levels in early summer. Second, high pool levels in summer, which are important to largemouth bass recruitment, can be provided without adversely affecting the recruitment of crappies, white bass, or saugeyes.

Novinger (1988) concluded that production of large year-classes of largemouth bass in Table Rock Reservoir was controlled by the timing, extent, and duration of flooding. Production of a strong year-class of largemouth bass could be achieved by manipulating water levels in the reservoir to flood no later than the middle of the largemouth bass spawning period and by maintaining high water levels through August. Biologists in other areas of the country have proposed similar plans to enhance year-class strength of fishes in reservoirs (Miranda et al. 1984; Ploskey 1986; Willis 1986).

Given the obvious benefits of high water to reservoir populations of largemouth bass, fisheries managers have attempted to artificially reproduce these effects. Most authors agree that the primary benefit of high water levels in reservoirs is increasing the amount of flooded vegetation available to age-0 black bass. Although some managers have attempted to change reservoir operations to artificially create floods (e.g., Ploskey 1986; Willis 1986), in most cases this is not possible because managing water levels for black bass would conflict with other water management plans. Therefore, reservoir managers have attempted to provide more cover for age-0 black bass and enhance their survival in years of low water by constructing shoreline habitat in areas with little natural cover.

Addition of spawning habitat may successfully increase year-class strength of black bass in systems where year-class strength is often fixed very early in life. Kramer and Smith (1962) found that year-class strength of largemouth bass in a natural lake was set by the time fish were 2 weeks old; in that system, increasing the number of fish that spawn may increase year-class strength. However, year-class strength of largemouth bass in Normandy Reservoir was set by late October. Novinger (1988) found a similar critical period in Table Rock Reservoir. In some reservoirs, enhancing spawning success would probably have little effect on year-class strength.

Novinger (1988) believed that any effect of habitat enhancement would be masked by systemwide effects of high water. We concur with this observation and believe that any increase in black bass year-class strength resulting from habitat enhancement in Tennessee tributary impoundments would be far outweighed by the typical increase gained in a high-water year. Trying to duplicate the effects of high water using artificial habitat enhancement would involve changing the habitat in virtually the entire reservoir, which would be prohibitively expensive. Maximizing the number of days at or over full pool in Normandy Reservoir will lead to more consistent recruitment, faster growth, and more individuals of virtually every sport fish species in the lake. Attempts to enhance year-class strength of largemouth bass in Tennessee impoundments should focus on the hydrology of systems and not on littoral habitat enhancement.

Acknowledgments

Funding for this project was provided by the Tennessee Wildlife Resources Agency (Federal Aid in Sport Fish Restoration, project FEW-6); the Tennessee Valley Authority; the Center for the

Management, Utilization, and Protection of Water Resources at Tennessee Technological University; and the Tennessee Cooperative Fishery Research Unit. We also acknowledge the graduate students at Tennessee Technological University who volunteered their time for field collections. Special thanks go to Frank Fiss, Tennessee Wildlife Resources Agency, who helped design and run this project for the first 3 years. Without his capable leadership, the success of this project would have been greatly lessened. We also express appreciation to Jeff Boxucker and two other anonymous reviewers whose thoughtful insights and constructive comments made this manuscript better.

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Journal of Fish Biology (2009) **74,** 1580–1593
doi:10.1111/j.1095-8649.2009.02231.x, available online at http://www.blackwell-synergy.com

Effects of river flows on growth of redbreast sunfish *Lepomis auritus* (Centrarchidae) in Georgia rivers

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(Received 11 July 2008, Accepted 10 February 2009)

Effects of river discharge on growth of redbreast sunfish *Lepomis auritus* were investigated in nine rivers in Georgia, U.S.A. Fish were aged and annular total length increments (L_{Tinc}) estimated from measurements from sectioned sagittal otoliths using the generalized regression model that held for the effects of decreasing L_{Tinc} from annual age (X): $L_{Tinc} = b_o - b_1(X) \pm b_i(D)$, where b_o, b_1 and b_i were the regression coefficients for the intercept and slopes and D, discharge, was either a single or multiple measurements of annular or seasonal flow volume or variation in flow volume. For eight of nine rivers, higher or greater variation in flows from April to June was associated with greater *L. auritus* growth; in the last river, higher flows from January to March were associated with greater fish growth. Across all rivers, *L. auritus* growth increments were 22, 45 and 36% greater in a wet year *v.* a dry year at ages 1, 2 and 3 years, respectively. Based on the results of this study, increasing water withdrawals by an additional 30% in five Georgia rivers would reduce the predicted number of *L. auritus* recruiting to 203 mm (angler preferred size) by 19–62%.

Key words: discharge; growth increments; water withdrawals.

INTRODUCTION

Variability of ecosystems exerts a great influence on the stability and persistence of fish populations. When environments are relatively stable, fish populations show low variation in rate functions (*i.e.* growth, mortality and recruitment) among years, population persistence is long and population dynamics tend to be driven by density-dependent factors (Diana, 1995). Many fish populations occur in highly unstable environments, however, which can cause large annual changes in rate functions, particularly recruitment (Maceina & Bettoli, 1998; Sammons & Bettoli, 2000; Smith *et al.*, 2005). Thus, fish population dynamics tend to be driven by abiotic or density-independent factors (Diana, 1995). Effects of abiotic factors on fish populations have been examined for many species in a variety of systems; however, most of the these

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studies have focused solely on recruitment variation or population persistence as mediated by abiotic factors (Turner *et al.*, 1994; Maceina *et al.*, 1998; Sammons & Bettoli, 2000; Arthington & Pusey, 2003; Matthews & Marsh-Matthews, 2003; Smith *et al.*, 2005).

Lotic systems constitute one of the most heterogeneous ecosystems in the world (Carline, 1986). Fish populations living in these environments must cope with long-term droughts (Matthews & Marsh-Matthews, 2003) and catastrophic floods (Kelsch, 1994), often on an annual basis (Bernardo *et al.*, 2003). Although floods often increase the amount of habitat and food available to fishes (Schlosser, 1998; Schwartz & Herricks, 2005), droughts often may also reduce available habitat greatly, forcing fishes into deeper refuges and leading to crowding and increased competition for food and space (Schlosser, 1998; Matthews & Marsh-Matthews, 2003). Much work has been conducted on the effects of variable flow in rivers on fish recruitment (Funk & Fleener, 1974; Turner *et al.*, 1994; Rogers *et al.*, 2005; Smith *et al.*, 2005). Comparatively few studies have investigated the effects of floods and droughts on growth rates of fishes; however, changes in growth rates can have great effects on fish populations (Adams *et al.*, 1982; Sammons *et al.*, 1999). Overall, the mechanisms by which droughts and floods affect fish populations remain poorly understood.

Sunfishes (Centrarchidae) are common sport fishes occurring in many lotic systems in the south-eastern U.S.A. Mean annual flows in these rivers can vary over three orders of magnitude, and long periods of droughts can occur periodically (U.S. Geological Survey river gauge data; water.usgs.gov). Conversely, wet conditions typically occur each year but vary in timing and duration. Thus, fishes in these river systems are subjected to a wide range of flow conditions over their life spans.

The redbreast sunfish *Lepomis auritus* (L.) is an important game fish and a keystone species in many rivers across the south-eastern U.S.A., and often supports important fisheries (Davis, 1972; Bass & Hitt, 1975; Sandow *et al.*, 1975; Coomer *et al.*, 1979). They commonly inhabit the main channels of lotic systems, from small streams to large rivers, and are typically found in areas with at least some flow (Etnier & Starnes, 1993). As visual predators, these fish commonly eat macroinvertebrates of a wide variety of families, including terrestrial species (Davis, 1972; Bass & Hitt, 1975; Sandow *et al.*, 1975; Coomer *et al.*, 1979). Like most centrarchids, *L. auritus* spawn in nests, and nest building typically begins once water temperatures reach *c.* 21° C (Davis, 1972; Bass & Hitt, 1975; Sandow *et al.*, 1975). Maturity typically occurs by age 2 years corresponding to 90–120 mm total length (L_T) (Etnier & Starnes, 1993).

Anecdotal evidence exists to suggest that river flows can affect growth rates of *Lepomis macrochirus* Rafinesque. Georgia Department of Natural Resources (GDNR) biologists noticed that when they stocked juvenile *L. macrochirus* to Georgia rivers in the spring, stocked juveniles were much larger in autumn samples following wet years compared to dry years (B. Deener, unpubl. data). From 1997 to 2005, central and southern Georgia followed a typical pattern of wet and dry years, with 1999, 2000 and 2001 characterized by dry conditions (annual rainfall 35–40% lower than mean) and 1997, 2002, 2003, 2004 and 2005 characterized by wet conditions (annual rainfall 10–15% higher than the mean; U.S. National Weather Service online data; www.srh.noaa.gov).

Therefore, fishes living in these systems in 2004 and 2005 experienced both dry and wet conditions during their lifetimes, affording an excellent opportunity to examine the effects of annual variations in flow regimes in Georgia rivers on growth and recruitment of *L. auritus*.

MATERIALS AND METHODS

STUDY SITES AND FIELD COLLECTION

Nine rivers were sampled for *L. auritus* (Table I), mostly located in the southern half of Georgia (Fig. 1). Based on mean annual discharge and approximate drainage area, most rivers sampled during this study ranged from small to medium coastal plain rivers (Table II). Fish were collected in 2004–2005 using a DC boat-mounted electrofishing unit; a total of 3108 fish were collected during this study (Table I). *Lepomis auritus* were killed in a 300 mg l^{-1} solution of MS-222 and then placed on ice. All fish were measured (L_T), and saggital otoliths were extracted and ages enumerated according to the methods described in Maceina (1988) and Buckmeier & Howells (2003). Otoliths were broken through the nucleus, mounted in thermoplastic cement and then ground until a thin section was created. Otoliths were then examined under an image analysis system (Image-Pro Plus, ver 4.5; www.mediacy.com); otolith measurements were taken from the focus to the outer edge of each annuli, and L_T at each annulus were calculated using the direct proportion method (DeVries & Frie, 1996). Although annuli were not directly validated, L_T frequencies of backcalculated age 1 year fish were compared to those of observed L_T frequencies of age 1 year fish collected from the Satilla River to ensure that backcalculated L_T were consonant with actual L_T. Furthermore, annuli formation has been validated for *L. macrochirus* (Schramm, 1989); therefore, the methods of ageing and measuring annuli used in this study were deemed valid. Based on *L. auritus* collected during the summer months in the Ocmulgee and Flint Rivers, the annulus appeared to be laid down each year by 30 June. Thus, L_T increments (L_{Tinc}) were calculated for each growth year (1 July to 30 June) using the equation: $L_{Tinc} = L_{Tn} - L_{Tn-1}$, where n = growth year.

DATA ANALYSIS

River discharge data were obtained from gauging stations maintained by the U.S. Geological Survey; discharge data were obtained from stations within the standardized sampling sites used by GDNR. Discharge data were obtained for each river for each

TABLE I. Study sites (see Fig. 1), when sampled, and number of *Lepomis auritus* (*n*) collected during this project

River	Collection times	*n*
Altamaha	November 2005	346
Flint	June 2004, July 2005	492
Ochlockonee	May 2004	208
Ocmulgee	June to August 2004	612
Oconee	November 2004, September to October 2005	190
Ogeechee	October 2004	300
Ohoopee	April to May 2004, May 2005	299
Satilla	March to Apr 2004	357
Savannah	October to November 2004, October 2005	304

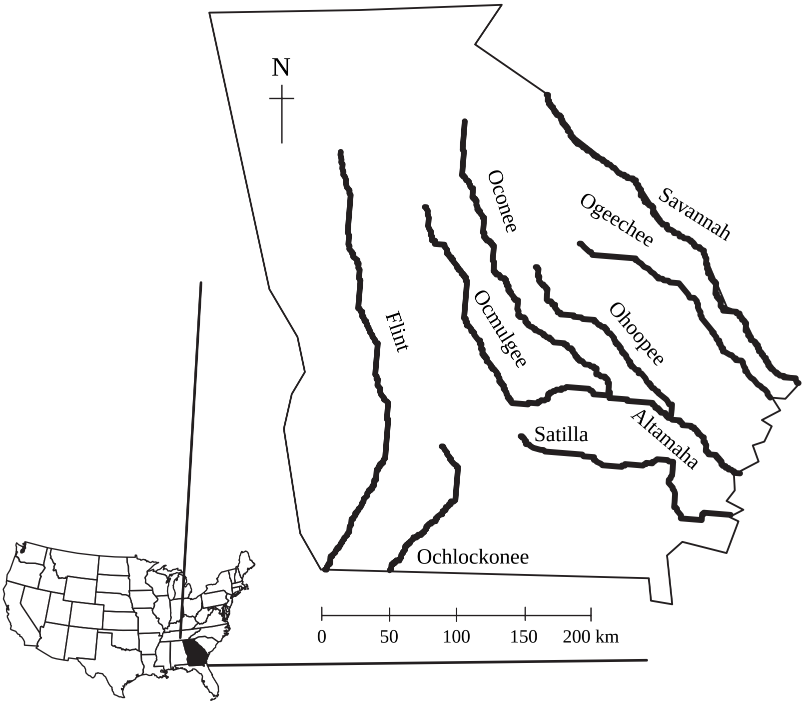

FIG. 1. Map of Georgia showing rivers sampled during this project.

growth year and for each quarter of the growth year (July to September, October to December, January to March and April to June) in an attempt to identify critical flow periods for *L. auritus* growth. Flow data examined included mean discharge, discharge variability [coefficient of variation (C.V.)], number of days mean daily discharge was <25% of the 50 year record of discharges and number of days mean daily discharge

TABLE II. Mean annual discharge and drainage area of all rivers sampled for *Lepomis auritus* in Georgia, 2004–2005. Data were taken from U.S. Geological Survey gauging stations located approximately where samples were collected. All rivers were sampled at locations within the greater coastal plain physiographic region. Size categories were derived from mean annual discharge: mainstem (>300 $m^3 s^{-1}$), large (150–300 $m^3 s^{-1}$), medium (50–150 $m^3 s^{-1}$) and small (<50 $m^3 s^{-1}$)

River	Size	Discharge ($m^3 s^{-1}$)	Drainage area (km^2)
Altamaha	Mainstem	384·1	35 224
Flint	Large	180·8	14 867
Ochlockonee	Small	30·0	1425
Ocmulgee	Large	152·8	13 416
Oconee	Medium	120·6	11 396
Ogeechee	Medium	64·5	6864
Ohoopee	Small	28·3	2875
Satilla	Small	29·6	3108
Savannah	Mainstem	327·2	25 512

was >75% of the 50 year record of discharges (Olden & Poff, 2003). Multiple regression analysis was used to assess relationships among river flow data and L_{Tinc} in each river (Maceina, 1992), using a generalized regression model that held for the effects of decreasing L_{Tinc} from annual age (X): $L_{Tinc} = b_o - b_1(X) \pm b_i(D)$, where b_o, b_1 and b_i were the regression coefficients for the intercept and slopes coefficients, and D, discharge, was either a single or multiple measurements of annular or seasonal flow volume or variation in flow volume. In each case, the candidate models were chosen based on Akaike information criteria (AIC) and Mallows' (1973) Cp statistic (Burnham & Anderson, 2002; SAS, 2004; www.sas.com). Semi-partial correlation coefficients (SCORR1; SAS, 2004) were calculated to determine the relative contribution of each independent variable to the overall coefficient of determination of the model in sequential order after age was entered. Squared partial correlation coefficients (PCORR2; SAS, 2004) were calculated for each independent variable to define the amount of variation in growth explained by flow variables after removing the effects of the other variables. Variance inflation and condition indices were used to choose the best model from among the candidate models, defined as the model that explained the greatest amount of variation in L_{Tinc} with the fewest number of independent variables.

To directly test the effects of river discharge on *L. auritus* growth, mean L_{Tinc} were compared between a dry year (mean discharge $\leq$25% of the 50 year mean) and a wet year (mean discharge $\geq$200% of the 50 year mean) in each river using a *t*-test with a Bonferroni correction ($P < 0{\cdot}007$; SAS, 2004). Comparisons were made for ages 1–3 years; if no fish were collected that were age 1–3 years in a dry or wet year, then that river was dropped from the analysis. To assess the effects of water withdrawals from rivers on *L. auritus* population size structure, regression models were created to predict growth increments of age 1–6 years *L. auritus* from river discharges in five rivers. Models were run for each river using river discharges over the entire growth year and each quarter of the growth year as described above; the best models were chosen using similar criteria described above. Mean L_{Tinc} were then estimated for age 1–6 years *L. auritus* by inserting the last 6 years of flow data from each river into each regression model to predict length increments. Then, mean discharge values were reduced by 30% to simulate a modest water withdrawal, and the models were rerun. L_{Tinc} increments were then used to calculate mean L_T at age 1–6 years under each discharge situation, and growth was described using the von Bertalanffy (1938) growth model. Coefficients from the model under each situation were incorporated into the fisheries analysis and simulation tools software (FAST; Slipke & Maceina, 2007), which uses the Jones modification of the Beverton–Holt equilibrium yield equation (Quinn & Deriso, 1999). Initial number was set at 100 individuals, and population models were run using the mean conditional natural mortality rates calculated using equations provided in the FAST programme, and over a wide range of exploitations. Number of fish (out of the initial 100) recruiting to 203 mm (assumed angler preferred size) were examined in each river and compared between discharge situations.

RESULTS

For all nine rivers, higher or greater variation in flow was associated with greater *L. auritus* growth; however, as expected, age always explained the most variation in growth increments in each model (Table III). Based on AIC scores and variance inflation and condition indices, the best models in all rivers were two-variable models, with age and one measurement of flow being the independent variables (Table III). Although all models contained statistically significant measurements of flow, these measurements explained $\leq$2·1% additional variation in growth increments in the Ocmulgee and Altamaha rivers, after accounting for the effects of age. Flow variables in the other seven rivers, however, explained $\geq$8·2% additional variation in L_{Tinc}, after accounting for the

TABLE III. Overall coefficients of determination (r^2), squared partial regression coefficients (PCORR) and semi-partial regression coefficients (SCORR) for relations between *Lepomis auritus* growth increments and water flow data in various time periods during the growth year. In each case the best model is presented, which explained the greatest amount of variation in growth with the least multicollinearity. Variables examined included discharge (Q) and coefficient of variation of discharge within each time period (C.V.). Time periods are indicated by a number or letter following the flow variable, and included January to March (3) and April to June (4)

River	r^2 (P-value)	Variable (P-value)	SCORR	PCORR
Altamaha	0·33 ($P < 0·001$)	Age ($P < 0·001$)	0·313	0·300
		C.V.$_4$ ($P < 0·05$)	0·015	0·015
Flint	0·71 ($P < 0·001$)	Age ($P < 0·001$)	0·604	0·672
		C.V.$_4$ ($P < 0·001$)	0·105	0·264
Ochlockonee	0·68 ($P < 0·001$)	Age ($P < 0·001$)	0·528	0·517
		Q_4 ($P < 0·001$)	0·156	0·330
Ocmulgee	0·63 ($P < 0·001$)	Age ($P < 0·001$)	0·603	0·612
		Q_4 ($P < 0·001$)	0·021	0·053
Oconee	0·48 ($P < 0·001$)	Age ($P < 0·001$)	0·396	0·317
		Q_3 ($P < 0·001$)	0·082	0·136
Ogeechee	0·61 ($P < 0·001$)	Age ($P < 0·001$)	0·458	0·397
		Q_4 ($P = 0·01$)	0·148	0·272
Ohoopee	0·66 ($P < 0·001$)	Age ($P < 0·001$)	0·497	0·491
		Q_4 ($P < 0·001$)	0·160	0·317
Satilla	0·61 ($P < 0·001$)	Age ($P < 0·001$)	0·426	0·411
		Q_4 ($P < 0·001$)	0·180	0·313
Savannah	0·63 ($P < 0·001$)	Age ($P < 0·001$)	0·536	0·614
		C.V.$_4$ ($P < 0·001$)	0·098	0·210

effects of age (Table III). While annual measurements of discharge were factors in determining *L. auritus* growth increments in all rivers, flow in April to June provided the best model in eight of nine rivers, explaining >26% of the variation in growth after removing the effects of age in five of nine rivers (Table III). The January to March discharge explained the most variation in *L. auritus* growth in the Oconee River (Table III). In all cases, relations between flow variables and growth increments were positive and thus growth increased as discharge (or variability) increased.

Growth increments of age 1 year fish were 13–62% greater in a wet year than a dry year (Fig. 2). Similarly, growth increments were 21–91% greater at age 2 years and 27–157% greater at age 3 years in a wet *v.* a dry year (Fig. 2). Across all rivers, *L. auritus* growth increments were 22, 45 and 36% greater in a wet *v.* a dry year at ages 1, 2 and 3 years, respectively (t-test, d.f. ≥ 465, $P < 0·001$). With flows reduced by 30%, the yield model predicted that there would be a 19–62% decline in *L. auritus* reaching 203 mm across the five rivers analysed (Fig. 3). Loss of preferred-sized *L. auritus* was predicted to be particularly severe in the Ohoopee and Savannah Rivers, with declines predicted to be ≥40% at angler exploitation rates ≥ 0·10.

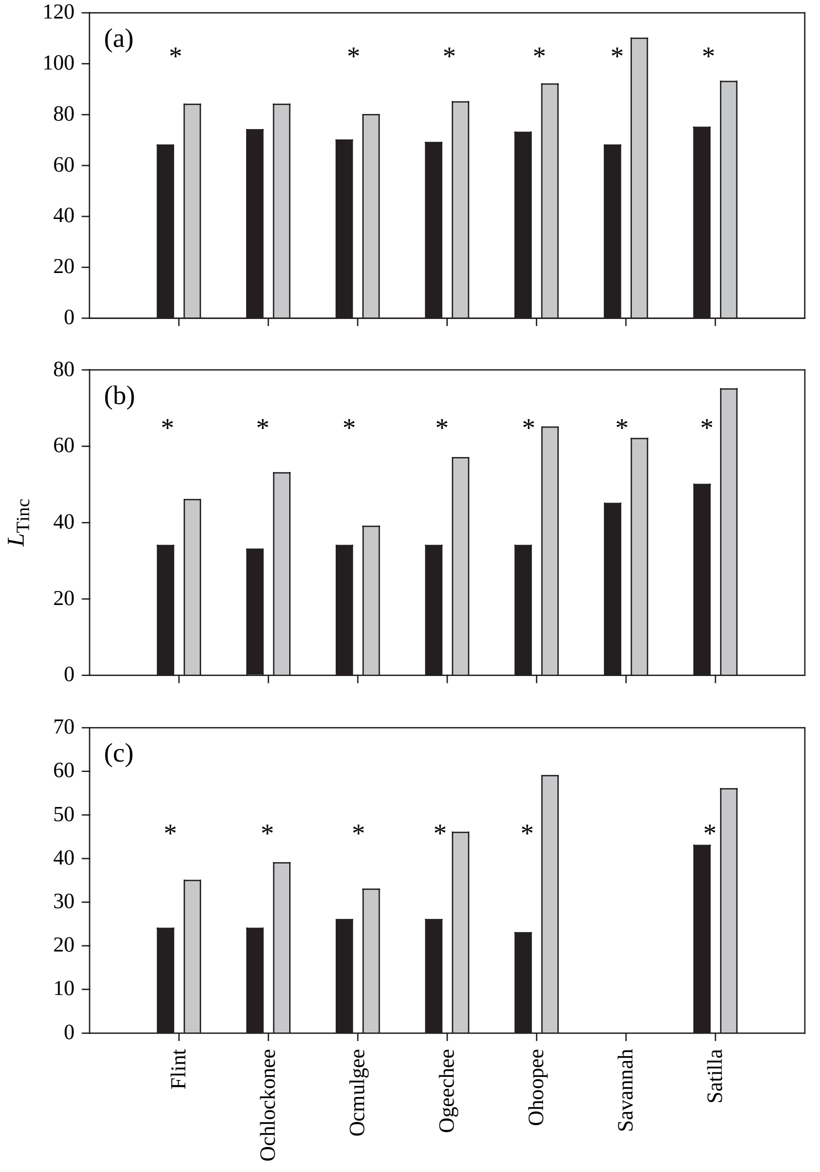

FIG. 2. Estimated mean total length increments (L_{Tinc}) of *Lepomis auritus* collected in seven Georgia rivers (see Fig. 1) in a wet (▨) and a dry (■) year at ages (a) 1, (b) 2 and (c) 3 years. *, Differences in mean growth increments between years (*t*-test; Bonferroni correction, $P < 0{\cdot}007$).

DISCUSSION

Age was the strongest predictor of growth in all cases. This was not surprising because growth of most fishes naturally declines with age (von Bertalanffy, 1938). Typically, fish growth is greatest for juvenile fishes, then sharply declines after onset of maturity (Carlander, 1977), which is usually age 2 years for

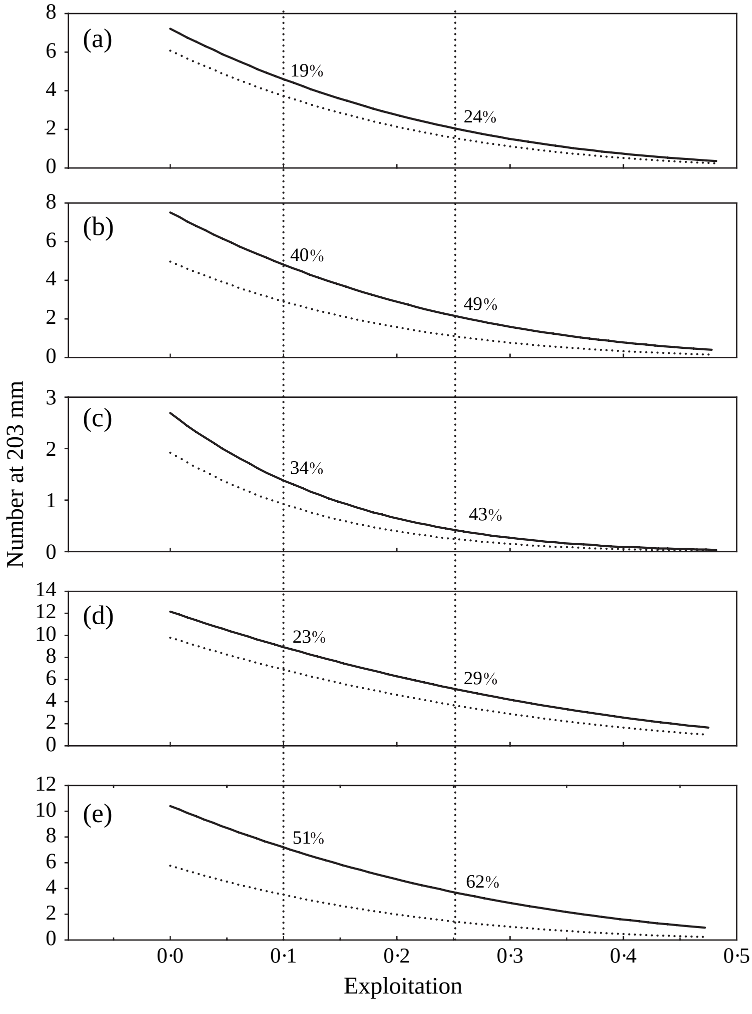

FIG. 3. Number of *Lepomis auritus* recruiting to 203 mm total length under two discharge situations [normal (——) and 30% reduction (· · ·)] and a range of exploitation rates in five Georgia rivers: (a) Ogeechee, (b) Ohoopee, (c) Ochlockonee, (d) Satilla and (e) Savannah. Populations were modelled with a conditional natural mortality of 0·45. Vertical lines denote exploitation rates of 10 and 25%, percentages indicate the decline of fish recruiting to 203 mm with a 30% decline in river discharge.

L. auritus (Bass & Hitt, 1975; Sandow *et al.*, 1975). While L_{Tinc} increments of *L. auritus* did decline with age in this study, growth remained relatively fast (L_{Tinc} typically >20 mm) for all ages of fish examined during this study.

Because many of the results of this study were based on backcalculated L_T at age, the possibility of bias resulting from Lee's phenomenon must be considered (Ricker, 1975). The short life span (maximum age = 7 years) and fast growth of *L. auritus* examined in this study probably limited the potential of Lee's phenomenon to bias the results of this study. In addition, most of the analyses in this study were driven by individual fish growth history. The regression models developed during this study were based on a growth year of a fish as a single observation. Therefore, results of these models indicated that the effects of flows hold constant within each fish, whether it happens to be a slow-growing fish or a fast-growing fish. Lee's phenomenon could bias results when comparing empirical data for arbitrarily defined wet and dry years for ages 1–3 years fish. Most of the wet and dry designations in this study, however, fell in adjacent years for all but two rivers, which eliminated the problem of Lee's phenomenon. Wet and dry years were 3 years apart in the Flint and Savannah Rivers; however, comparisons of growth increments between wet and dry years revealed similar results to those found in the other rivers, suggesting no effect of Lee's phenomenon.

Growth of *L. auritus* was positively related to flow in Georgia rivers. April to June discharge was the best environmental predictor of *L. auritus* growth in five of nine rivers; discharge C.V. in April to June was the best environmental predictor of growth in three additional rivers. Growth increased as discharge increased, whether measured directly as mean daily discharge or indirectly, such as by discharge C.V. Georgia rivers are characterized by relatively stable discharge when flow is low; thus, higher C.V. would result from flooding events, which would also increase mean daily discharge. High river flows probably benefited *L. auritus* growth by creating shallow floodplain habitat that offered more habitat, a refuge from flows and greater terrestrial invertebrate food resources (Schlosser, 1998). Sandow *et al.* (1975) found that *L. auritus* were opportunistic feeders in the Satilla River, Georgia, consuming a wide variety of both terrestrial and aquatic invertebrates. Thus, these species may be adapted to take advantage of new food resources created by newly inundated floodplains when river discharge increases.

During high flows, fishes often move into newly inundated areas, possibly to take advantage of increased habitat or seeking a refuge from high flows (Kwak, 1988; Schwartz & Herricks, 2005); however, centrarchids are not known to be a highly mobile species. Johnston & Smithson (2000) found that longear sunfish *Lepomis megalotis* (Rafinesque) and green sunfish *Lepomis cyanellus* Rafinesque generally did not move from their home pools in a small Arkansas stream. In contrast, Hudson & Hester (1976) found that *c.* 58% of tagged *L. auritus* moved >0·16 km from their release site in a larger North Carolina river. Kwak (1988) reported that *L. cyanellus* and orangespotted sunfish *Lepomis humilis* (Girard) commonly moved up onto the floodplain when flows increased in an Illinois river and returned to the main channel when flows subsided.

Floodplains are obviously an important component of lotic systems and provide habitat and food for fishes during high-flow events. Neckles *et al.* (1990) found that invertebrate production was greater in seasonally flooded habitats than in more permanently flooded areas. Elevated discharge in experimental streams increased the supply of insects for juvenile creek chubs *Semotilus atromaculatus* (Mitchell) (Schlosser, 1998). A drought resulted in a 40% reduction of the total number of invertebrates produced in a small British stream; however, no effect on brown trout *Salmo trutta* L. or Atlantic salmon *Salmo salar* L. growth rates were observed (Cowx *et al.*, 1984). In contrast, growth increments of *L. auritus* were much smaller in a dry year *v.* a wet year in most of the Georgia rivers examined during this study. Thus, low water flows obviously have great consequences for growth of *L. auritus* in these rivers. *Lepomis macrochirus*, *L. cyanellus* and dollar sunfish *Lepomis marginatus* (Holbrook) moved into floodplains while they were inundated in Black Creek, Mississippi, and most fishes collected in the floodplain had full guts, suggesting active feeding (Ross & Baker, 1983). Similarly, stomach fullness of omnivorous fishes increased when floodplains of the Amazon River became inundated, resulting in a 60% increase in growth (Bayley, 1988).

Timing of flooding is probably an important determinate of fish growth; to maximize the growth advantage gained by flooding terrestrial habitats, flooding must occur when water temperatures are in the optimum range to allow fishes to take advantage of the increased food supply created by newly inundated floodplains. Bayley (1988) found that timing and extent of flooding in the Amazon River were important in determining growth of three fish species; mean stomach fullness of all three species was highest during the rising water period of January to April (Santos, 1981), which corresponded to the highest growth rate period in that study (Bayley, 1988). High flow events in April to June were the best environmental predictor of *L. auritus* growth in 89% of the Georgia rivers examined in this study. Obviously, discharge during this 3 month period was a critical determinant of *L. auritus* growth in Georgia rivers. This period falls in the prespawn and spawning period in the Georgia rivers examined during this study, when fishes often increase feeding to grow gonadal tissue in preparation for spawning (Neumann *et al.*, 1994; Diana, 1995). Also, by April, water temperatures have often warmed to the level that the increased food supply created by high water events can be utilized most efficiently by *L. auritus*, resulting in the observed increased growth rates. In contrast, water temperatures during summer may be too high to allow fast growth because metabolic costs may be too great (Neumann *et al.*, 1994; Dent & Lutterschmidt, 2003). Similarly, high flows are common in Georgia rivers during the winter due to the prevalent precipitation patterns but may not have as great an effect on growth due to: (1) lower abundance of terrestrial insects in winter and (2) slower digestion rates by *L. auritus* caused by low water temperatures that may not allow food resources to be used efficiently.

Most of the strongest relations between discharge and *L. auritus* growth were found in small-sized to medium-sized coastal plain rivers. These rivers tended to have extensive floodplains that were connected to the main river channel only during high-flow events (B. Deener, pers. comm.). Larger coastal plain rivers (*i.e.* the Ocmulgee and Altamaha Rivers) generally had weak relations between flow and *L. auritus* growth, which may be due to the fact that these rivers had large expanses of oxbow lakes that provided excellent habitat for *L. auritus* and were always connected to the main river channel at all flows. In contrast, most of the Flint River contained limited floodplain areas; in addition, the lower third of the Flint River had been channelized by the U.S. Army Corps of Engineers in the mid 1800s (A. Kaeser, pers. comm.). Thus, it was no surprise that flow appeared to have a reduced effect on *L. auritus* growth in the Flint River.

Obviously, river morphology and floodplain connectivity were probably important factors determining the effects of discharge on *L. auritus* growth in Georgia rivers. Rutherford *et al.* (1995) found little relation between river flow and growth of centrarchids in the Mississippi River and stated that floodplain alterations in the Mississippi River basin may have resulted in less favourable conditions for floodplain-dependent species such as centrarchids. Growth of *Ictalurus punctatus* (Rafinesque) increased with higher flows in one section of the Kansas River that was characterized by good floodplain connectivity; however, no relation between growth increments and river flow in another section of the river that was more urbanized and less connected to the floodplain (Quist & Guy, 1998). Based on the results of the present study, it appeared that flow had the greatest effect on *L. auritus* growth in Georgia rivers that had extensive floodplains that were only connected to the main river channel by high flow events. Relations between flow and *L. auritus* growth were less in rivers where the floodplain was connected to the river at most discharge levels or those that had either small floodplain areas or floodplains that were only connected to the main river during extremely high-flow (*i.e.* rare) events.

MANAGEMENT IMPLICATIONS

The results of this study predicted that increasing water withdrawals by an additional 30% in five Georgia rivers would reduce the number of *L. auritus* recruiting at 203 mm by at least 19%. In many cases, the number of fish reaching 203 mm were commonly predicted to decline 40–50% with only a 30% decrease in flow. *Lepomis auritus* are one of the most important species sought by anglers on Georgia rivers (Coomer *et al.*, 1979; Thomas, 1995), and such declines in the number of 203 mm fish would certainly have grave consequences for these fisheries. Furthermore, *L. auritus* typically dominate fish communities in many of these rivers, both numerically and in biomass (Sandow *et al.*, 1975). Reductions in size structure of these populations as predicted by this study could have far-reaching implications for the entire lotic ecosystem. *Lepomis auritus* serve as important diet items for predators such as largemouth bass *Micropterus salmoides* (Lacépède) and the endemic shoal bass *Micropterus cataractae* Williams & Burgess (unpubl. data). A decline of large *L. auritus* in these systems could deprive larger individuals of these species of a preferred size of prey (Sammons & Maceina, 2006), causing their growth rates to decline. Obviously, *L. auritus* can serve as an indicator species for ecological change due to increased water withdrawals in these systems, which would be a great benefit to fisheries managers seeking to justify environmental flows for fishes.

Funding for this project was provided by the Georgia Department of Natural Resources through Federal Aid to Sport Fish Restoration Project F-77. Most of the fish used in this study were collected by GDNR crews under the direction of J. Evans, R. Martin, D. Harrison, M. Geihsler, T. Will and T. Barrett. The authors would like to express their appreciation to L. Ager, R. Weller, H. Deener, M. Thomas, J. Biagi, M. Spencer and C. Coomer, GDNR, for their support of this project.

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Chapter 13
Centrarchid identification and natural history

M. L. Warren, Jr.

13.1 Introduction

The family Centrarchidae (Order: Perciformes) is one of the most diverse, widespread, and conspicuous fish families native to freshwater habitats of North America. Among endemic fish families of North America, only the North American catfish family (Ictaluridae) has more species. The family name, Centrarchidae, refers to the anal fin spines of species in the family, and the common name, sunfishes, to the bright breeding colors displayed by males of some species in the family. Because of their diversity, wide distribution, and economic value, some of the earliest taxonomic descriptions and natural history observations on North American freshwater fishes focused on the centrarchids (e.g., Linnaeus 1758; Lacépède 1801; Rafinesque 1820; Abbott 1870).

The family contains 34 extant species classified in eight genera, but morphological and genetic evidence suggests that additional, but currently unrecognized, diversity exists within most of tbe genera. The most diverse genus, *Lepomis*, the bream (or panfish) of anglers, is comprised of 13 extant species, but at least 8 of these show evidence of polytypy (e.g., Bermingham and Avise 1986; Fox 1997; Harris 2005). The genus *Micropterus*, referred to collectively as black basses (Philipp and Ridgway 2002), contains eight extant species, but again, at least three species are polytypic (e.g., Stark and Echelle 1998; Kassler 2002; Miller 2005). The genera *Ambloplites* (rock basses), *Enneacanthus* (handed sunfishes), and *Pomoxis* (crappies) contain four, three, and two extant species, respectively, and at least one species each of *Ambloplites* and *Enneacanthus* is polytypic (Koppelman 2000; T. Darden, South Carolina Department of Natural Resources, personal communication). The genera *Acantharchus, Archoplites*, and *Centrarchus* are monotypic, but populations of both *Acantharchus pomotis* and *Archoplites interruptus* show geographical patterns of morphological divergence (Cashner *et al*. 1989; Moyle 2002).

The natural range of extant centrarchids is confined primarily to warm, freshwater habitats in North America east of the western continental divide except for the Sacramento perch (*A. interruptus*), whose native range is west of the divide in the Central Valley of California (San Joaquin-Sacramento, Pajaro, Salinas river drainages, Moyle 2002). The northern natural continental limit of the family is occupied by members of *Lepomis, Ambloplites, Pomoxis*, and *Micropterus* in the St. Lawrence River, northern Great Lakes, and southwestern Hudson Bay drainages in eastern Canada (Scott and Crossman 1973). The Rio Conchos (Rio Grande drainage) (*Lepomis*) and Rio Soto la Marina (*Micropterus*, Miller and Smith 1986; Miller 2005) of northern Mexico delimit the southern continental limits of the native range of extant centrarchids. The Mississippi River Basin and, to a lesser extent, the Gulf and Atlantic Slope drainages harbor the most diverse assemblages of native centrarchids (Warren *et al*. 2000). The native ranges of *Pomoxis* and *Lepomis* largely coincide with that of *Micropterus*, but both extend farther northwest into the northern plains drainages, and the native range of *Lepomis* extends farther northeast into southern New Brunswick (Scott and Crossman 1973). Members of *Acantharchus* and *Enneacanthus* are confined to drainages of the Atlantic Coastal Plain, peninsular Florida, and eastern Gulf Coastal Plain (Page and Burr 1991). The native range of *Centrarchus* overlaps *Acantharchus* and *Enneacanthus* but extends into drainages of the western Gulf Coastal Plain of eastern Texas and north to southern Illinois and Indiana in the lower Mississippi River Basin. Centrarchids, particularly the genera *Ambloplites, Lepomis, Micropterus*, and *Pomoxis* are among the most widely introduced groups of fishes in the world. Nonnative populations are established across much of temperate North America and intercontinentally (e.g., South America, Europe, Africa, Asia, Oceania) and are often associated with adverse ecological consequences for the native fauna (e.g., Robbins and MacCrimmon 1974; De Moor and Bruton 1988; FAO 1998; Fuller *et al*. 1999; Rahel 2000; Jackson 2002; Jang *et al*. 2002; Moyle 2002).

The most distinctive characteristic of centrarchids is their reproductive behavior. Males in the family construct and defend a well-defined, depressional, oval- to circular-shaped nest. Downward-directed thrusts of the caudal fin are a primary and conspicuous nest-building activity in most centrarchids (caudal sweeping, Miller 1963), but a variety of other actions may also be used as the male clears the nesting area (e.g., sweeping of the pectoral fins, pushing stones, or transporting debris by mouth) (Dickson 1949; Hunter 1963; Miller 1963; Gross and Nowell 1980; Noltie and Keenleyside 1987b). Centrarchids may nest solitarily or colonially. Solitary nesters (nests >1 m apart) tend to nest near simple cover (e.g., bases of logs, rocks, or macrophytes) and defend a territory exceeding the nest perimeter (>2.5 m, Colgan and Ealey 1973; Avila 1976; Winemiller and Taylor 1982; Colgan and Brown 1988; Ridgway 1988; Jennings and Philipp 1992b; Scott 1996). Colonies of nests, consisting of several to hundreds of abutting nests, tend to occur in shallow open water, and in dense colonies nest defense is constrained primarily to the nest perimeter (Hunter 1963; Colgan *et al.* 1981; Gross and MacMillan 1981; Gross 1982). Spawning can occur immediately after nest construction or be delayed for several days, during which the male defends the nest and surrounding territory and waits for spawning-ready females (Carr 1946; Kramer and Smith 1962; Boyer and Vogele 1971; Miller and Kramer 1971; Avila 1976; Vogele 1975a; Colgan and Gross 1977; Gross and Nowell 1980; Cooke *et al.* 2001b).

Male aggression intensifies during the courtship and spawning period. Males over nests display to nearby or approaching males and females using combinations of many behaviors (e.g., caudal sweeping, nest hovering, fin spreading, mouth gapes, jaw snaps, lateral displays, substrate biting, and opercular spreads). Male to male aggressive interactions, including combat, are not uncommon, particularly among colonial-nesting species. Males most frequently rush toward an interloper with a quick retreat to the nest (thrust, Miller 1963), but if the intruder does not retreat, males laterally display, spread opercles, or actually ram, push, bite, or jaw grasp the other male. Much of male aggression is directed at or near the head and opercular area, but frayed fins and body abrasions of males attest to the vigorousness of male aggression in defense of the nesting territory (Hunter 1963; Keenleyside 1967, 1971; Colgan and Gross 1977; Gross and Nowell 1980).

Male courtship of females may be preceded by attempts to repulse females near the nest, behaviors that coax or guide the female to the nest, or both. Repeated repulsion of approaching females by males is documented in *Archoplites* (Mathews 1965), *Ambloplites* (Gross and Nowell 1980; Petrimoulx 1984; Noltie and Keenleyside 1987b), *Lepomis* (e.g., Hunter 1963; Huck and Gunning 1967; Keenleyside 1967; Ballantyne and Colgan 1978a,b,c), and *Pomoxis* (Siefert 1968). If ready to spawn, a female, assuming a subordinate demeanor, continues to slowly approach the nest despite repeated attacks by the male. Male-leading or -guiding courtship behaviors are known in *Lepomis, Micropterus*, and *Centrarchus*, although *Lepomis* females often enter nests with little or no overt courtship (Carr 1942; Dickson 1949; Hunter 1963; Keenleyside 1967; Chew 1974; Coble 1975; Vogele 1975a; Avila 1976; Gross 1982; Ridgway *et al.* 1989; Lukas and Orth 1993; Cooke *et al.* 2001b). Repulsing or guiding male behaviors directed at females may be species or context specific, are difficult to separate cleanly into courtship or aggression, and often co-occur (Keenleyside 1967; Ballantyne and Colgan 1978a,b,c).

Once a pair is situated over the nest, they orient broadside and head to head and swim in slow, tight circles over the nest. The pair settles to the substrate, and egg deposition occurs as the female tilts away from the male and presses her vent near the substrate; the male presses his vent to the female's while remaining upright or rolling toward the female. Egg and sperm release is accompanied by shuddering in both sexes; the demersal, adhesive eggs adhere to the nest substrate and to one another in clumps. Typically the pair rests, then repeats the sequence multiple times, until the male chases the female out of the nest. Rests between spawning bouts tend to shorten as the spawning event continues. These sequences may be in quick succession if the pair is not interrupted by intruders, but completion of spawning with a single female may occur over extended periods (15 minutes to 3.5 hours), even without interruption (Siefert 1968; Neves 1975; Vogele 1975a; Gross 1982, 1991; Isaac *et al.* 1998; Cooke *et al.* 2001b). After spawning, males aggressively guard the eggs and larvae, but the length of male parental care after the eggs hatch differs among genera and species within genera.

Today, centrarchids are the primary focus of the recreational fishing industry in the United States and much of southeastern Canada. The relatively large size of many centrarchids, vulnerability to natural baits or artificial lures, and the excellent taste of the flesh combine to create a popular sport fishery worth billions of dollars a year. The black basses (*Micropterus*), particularly the Florida bass and largemouth bass, the bream or panfishes (*Lepomis*), especially the bluegill, and the crappies (*Pomoxis*) are sought by anglers more than any fresh or saltwater sport fishes in the United States. Angler numbers and days spent fishing for centrarchids dwarf those reported for salmonids, walleye, or saltwater fishes (USFWS 2002).

A prodigious body of information is available on centrarchid natural history. Most research, however, has focused on a relatively few but important sport fish species, and there is no single-source recent summary of natural history information for all species in family. The objective here is to provide synopses of the characteristics and the natural history of the

8 genera and 34 species of centrarchid fishes and to provide a dichotomous key to the family. A secondary objective of this chapter is to highlight species for which information on their natural history is lacking, fragmentary or anecdotal.

13.2 Generic and species accounts

The bulk of the chapter consists of a separate account for each genus and each species within a genus, with the exception of monotypic genera. Only species accounts are given for monotypic genera. Within the characteristics sections of generic and species accounts, the definition of counts, standard length (SL), total length (TL), and other measurements follow standard ichthyological methods (see Page and Burr 1991; Jenkins and Burkhead 1994; Boschung and Mayden 2004) or are given in the citations associated with that section. Counts are presented as a total range, that is, 19 to 25; a modal (usual) count followed by a range, that is, usually 22, 19 to 25; or the most frequently encountered range of counts (ca. ≥90%) and the extremes, that is, (19)21 to 23(25). Only published sources were used to designate a confirmed freshwater mussel host (e.g., mussel larvae successfully infected and transformed on a centrarchid host). A putative host is similarly defined, except that the data are from unpublished sources and need verification. Published or unpublished accounts of mussel larvae infection on a centrarchid species without observation of transformation to the juvenile stage are not included.

13.3 *Acantharchus pomotis* (Baird)

13.3.0.1 Mud sunfish

Characteristics: Moderately oblong and robust body, depth <0.4 of SL. Large, terminal mouth, lower jaw projecting slightly, supramaxilla large (≤2 times into length of maxilla), upper jaw extending beyond middle of eye. Eye large, diameter greater than snout length. Three to four parallel, brown to olive-black stripes across face (above eye, through eye, along upper jaw) and four to five dark brown stripes along side, often broken into mottling. Opercle with two flat extensions; opercular tab short and deep, spot prominent, dark brown to black, with orange (in large individuals) or light ventral and dorsal edges. Rounded caudal fin. Long dorsal fin, 10 to 12 spines, 9 to 13 rays, 20 to 24 total; and moderate length anal fin, 4 to 6 spines, 9 to 11 rays, 14 to 16 total. Dorsal fin continuous with shallow gap between spines and rays. Dorsal fin base about 1.7 to 1.9 times longer than anal fin base. Stout, moderate length gill rakers (5–7). Cycloid scales on head and body. Lateral line scales, 32 to 45; cheek scale rows, (5)6 to 8(9); breast scale rows, (10)12 to 14(16); branchiostegal rays, 7; pectoral rays, 14 to 15; vertebrae, 29 or 30. Teeth on endopterygoid, ectopterygoid, palatine (villiform), and glossohyal (tongue, one elongate patch) bones; vertebrae, 30 (13 + 17) (Bailey 1938; Cashner 1974; Cashner *et al.* 1989; Page and Burr 1991; Mabee 1993).

Size and age: Typically 25 to 91 mm TL at age 1. Large individuals measure 150 mm TL and reach age 4+ to 8+ (maximum 206 mm TL, 190 g) (Breder and Redmond 1929; Mansueti and Elser 1953; Cashner *et al.* 1989; Page and Burr 1991; Pardue 1993; Jenkins and Burkhead 1994). North Carolina populations grew more rapidly in length and were shorter lived (4 vs 7–8 years) than populations in Maryland and New York (Mansueti and Elser 1953; Pardue 1993).

Coloration: Dorsum and background of sides light olive or greenish gold to dark green or brown; olive to chocolate brown longitudinal stripes or mottling on sides. Ventral head and breast yellowish tan, mottled posteriorly on belly to flanks. Median fins olivaceous to dark brown, may be mottled in small individuals. Tips of anal spines and rays often darkened to produce marginal band. Caudal with broad, dark band at base; median rays may be darkened from base to tip, creating a striped effect. Dull red or brown iris. Little sexual dimorphism evident and no perceptible color changes occur in the breeding season, but chocolate brown mottling and ear tab tend to be darker in males than in females. Young may have up to 15 thin stripes along sides punctuated by dark pigment producing a somewhat spotted lateral pattern (Cashner *et al.* 1989; Page and Burr 1991; Pardue 1993; Jenkins and Burkhead 1994; Marcy *et al.* 2005).

Native range: The mud sunfish occurs primarily on the Atlantic Coastal Plain and in lower Piedmont drainages from Hudson River, New York, to St. Johns River, Florida, and also occupies the extreme eastern Gulf Coastal Plain drainages from the Suwannee to St. Marks rivers in northern Florida and Georgia (Page and Burr 1991).

Habitat: The mud sunfish is a decidedly lowland species, inhabiting sluggish waters of swamps, vegetated lakes, ponds, sloughs, and backwaters and pools of creeks and small to medium rivers. The species occurs across a broad range of pH (about 4–9) and in a study of New Jersey lakes was significantly more frequent in acidic waters (Graham 1993). The species is most often associated with plants, detritus, undercut banks, instream wood, and other cover (Page and Burr 1991; Pardue 1993; Jenkins and Burkhead 1994). In a North Carolina swamp, 70% of individuals recaptured (31 total) were within 0.2 km, and 30% moved 2.7 to 4.9 km from where they were marked. Increased movements occur from January to May, presumably in association with spawning activity, lower water temperatures, and higher water levels (Pardue 1993). Mud sunfish frequently invade intermittent tributaries and wetlands that dry infrequently (Snodgrass *et al.* 1996; Marcy *et al.* 2005).

Food: The mud sunfish is reputed to be active at night, maintaining close affinity with and resting head down in vegetative cover during daylight (e.g., Abbott 1870; Breder and Redmond 1929; Mansueti and Elser 1953; Laerm and Freeman 1986), but quantitative studies of diel activity or feeding are lacking. Decapods, amphipods, odonates, and coleopterans form the primary diet of juveniles and adults, but small fish begin to be included in the diet at least seasonally when individuals reach >105 mm TL (Pardue 1993).

Reproduction: Maturity is reached at age 1+ and a minimum size of 66 to 140 mm TL. Spent females, egg sizes, and gonad to body weight ratios suggest that the mud sunfish begins and completes spawning at temperatures as low as 7 to 10°C (Pardue 1993), which is lower than minima reported for other centrarchids. The spawning period apparently extends from December to May in North Carolina and into June in New Jersey at water temperatures of 7 to 20°C (Breder 1936; Pardue 1993). The ovaries enlarge in the early fall and continue developing over winter (Pardue 1993), which is likely an adaptation for early spawning. Reproductive behaviors are essentially unknown. Males have been observed or captured over small depressional nests near the shoreline of lakes or near the banks of headwater streams in water 15 to 30 cm deep (Fowler 1923; Marcy *et al.* 2005). Mud sunfish produce audible grunting noises (Gerald 1971), but linkage with reproduction is undocumented. Mature ovarian eggs range from 0.7 to 1.1 mm diameter (Pardue 1993). At a median size of 128 mm TL, a female can produce 2304 mature eggs (range: 1515 at 114 mm TL to 3812 at 144 mm TL; data from Pardue 1993), which is one of the lowest batch fecundities among centrarchids (see also *Ambloplites* and *Enneacanthus*). Female allocation of energy to reproduction is also low relative to most centrarchids with peak female gonad to somatic weight values of 3% (Pardue 1993). Mature ovarian egg size is similar to that in *Lepomis* and may indicate a similar duration of male care provided to the embryos and larvae (Gross and Sargent 1985), but the combination of low batch fecundity and low female energy allocated to reproduction differs from reproductive patterns observed in all other centrarchids.

Nest associates: None known.

Freshwater mussel host: None known.

Conservation status: The mud sunfish is widely distributed but not common anywhere. The species appears to be secure where its lowland habitats are undisturbed, particularly in the central portions of its Atlantic Coastal Plain range (North and South Carolina). Populations to the north and south are considered possibly extirpated (New York), imperiled (Delaware and Maryland), or vulnerable (Virginia, Georgia, and Florida) (NatureServe 2006).

Similar species: All other centrarchids have ctenoid scales (cycloid in *Acantharchus*), and except for *Enneacanthus*, deeply to shallowly emarginate caudal fins (rounded in *Acantharchus* and *Enneacanthus*). *Enneacanthus* possess three anal fin spines (4–6 in *Acantharchus*).

Systematic notes: The phylogenetic relationships of the monotypic genus *Acantharchus* to other centrarchid genera is the least resolved within the family. Phylogenetic analyses place the species as sister to all other centrarchids or as resolved within a clade of all centrarchid genera but *Lepomis* and *Micropterus* (Roe *et al.* 2002; Near *et al.* 2004, 2005). The species shows evidence of polytypy. A subspecies described from the Okefenokee Swamp region (Suwannee River drainage, Georgia) as *A. pomotis mizelli* (Fowler 1945) was based on little comparative data. In an extensive study of geographic variation, several meristic characters of populations in eastern Gulf of Mexico drainages diverged significantly from those of populations in Atlantic Slope drainages. Multivariate analyses of morphological characters suggested that a contact zone between northern Atlantic Slope populations and Gulf Slope populations exists in Atlantic Slope drainages of Georgia and Florida (Cashner *et al.* 1989). Resolution of the evolutionary distinctiveness of the two geographic groups awaits molecular phylogeographic analysis.

Importance to humans: The mud sunfish is one of the least known of all centrarchids, even to avid sport fishers, fisheries biologists, and most ichthyologists. The species is apparently rarely taken by hook and line and can go uncaught and unnoticed by anglers even when it occurs in heavily fished ponds (Mansueti and Elser 1953). Unfortunately, so little is known about the species that its ecological function and value in lowland stream and wetland ecosystems cannot be evaluated, but its adaptability to such habitats and distribution across a broad latitudinal band suggest a long evolutionary history in those environments and a potentially important functional role. The basal phylogenetic relationship of *Acantharchus* within the centrarchids may provide an important key for unraveling the relationship of the centrarchids to other percoid fishes, a relationship that is currently unknown. Likewise, study of its reproductive biology and behavior could illuminate the evolutionary history of complex reproductive strategies and associated behaviors observed in other centrarchids.

13.4 *Ambloplites* Rafinesque

The monophyletic genus *Ambloplites*, often referred to collectively as rock basses, is endemic to eastern North America and contains four species consisting of two sister group pairs: *Ambloplites ariommus* (shadow bass) and *Ambloplites rupestris* (rock bass) form one sister pair and *Ambloplites cavifrons* (Roanoke bass) and *Ambloplites constellatus* (Ozark bass), the other. *Ambloplites* is sister to the monotypic genus *Archoplites*, represented by the Sacramento perch, and these two genera are sister to the genus *Pomoxis* (Near *et al.* 2004, 2005). The genus is distributed broadly across eastern North America, mostly east of the Great Plains, from southern Canada to the Gulf Coastal Plain, but the natural ranges of all four species are allopatric within this region. The Roanoke bass–Ozark bass sister pair occupies some of the smallest ranges of any North American sport fish. The Roanoke bass is endemic to Atlantic Coast drainages of Virginia and North Carolina and the Ozark bass mostly to the White River of Arkansas and Missouri. The range of the shadow bass is essentially disjunct; part of the range includes drainages of the eastern Gulf Slope and lower Mississippi River and the remainder includes drainages of the Ouachita Mountains, Arkansas River Valley, and Ozark Plateau. The rock bass, the most broadly distributed member of the genus, has been introduced and is widely established outside its native range in both eastern and western North America (Cashner and Suttkus 1977; Fuller *et al.* 1999). Intentional (or suspected) introductions of rock bass and other species of *Ambloplites* into the ranges of congeners has obscured natural ranges, has produced introgressed populations, and threatens the genetic integrity of species within the genus, particularly the range-restricted endemics (Cashner and Suttkus 1977; Cashner and Jenkins 1982; Jenkins and Burkhead 1994; Koppelman *et al.* 2000).

Ambloplites appear to differ from most other centrarchids, except their sister genus *Pomoxis*, in several aspects of reproductive behavior, but detailed, multiple observations are available only for rock bass. Male *Ambloplites* apparently do not use caudal sweeping to clear nesting areas as is common in most other centrarchid males (Miller 1963). *Ambloplites* males use a combination of behaviors to construct the nest, including undulations of the anal fin, sweeping of the pectoral fins, and pushing material forward with outstretched pectoral fins (bulldozing, Gross and Nowell 1980; Petrimoulx 1984; Noltie and Keenleyside 1987b). Males orient slightly head downward and use alternating strokes of the pectoral fins for fanning the eggs, similar to *Pomoxis*, rather than the horizontally oriented and primarily caudal- fin fanning as described for *Lepomis* or *Micropterus* (Carr 1942; Miller 1963; Gross and Nowell 1980; Noltie and Keenleyside 1987b). Males show no overt courtship of females, and mate choice appears to be restricted to male acceptance of females (Gross and Nowell 1980; Petrimoulx 1984). Males aggressively and persistently repel and even attack females approaching the nest, spawning only with the most persistent, submissive females, behaviors in contrast to the active leading or guiding behaviors of nest-defending males toward females in other genera (e.g., *Lepomis* and *Micropterus*). The relative position of the male to the female during spawning also appears to differ in, and perhaps among, *Ambloplites*. The male of the Roanoke and Ozark bass occupies a central nest position during pairings with females rather than a position outside the female (toward the nest rim); the rock bass male takes an outside nest position in spawning if circling occurs, but occupies a central position when no nest circling occurs (Gross and Nowell 1980; Petrimoulx 1984; Noltie and Keenleyside 1987b; Walters *et al.* 2000).

Members of *Ambloplites* are popular sport and food fishes and are commonly taken by anglers. In Missouri, three species, the shadow bass, rock bass, and Ozark bass, comprise 10% of the catch and harvest of fishes in streams (Koppelman *et al.* 2000). Many individuals are caught incidentally with the same lures and tackle used by anglers seeking smallmouth, spotted, and redeye basses, which frequently co-occur with species of *Ambloplites*. Anglers specifically seeking rock basses use small lures and spinners, lures imitating minnows, or live bait, particularly dobsonfly larvae (hellgrammites) and small crayfishes (Nielsen and Orth 1988; Ross 2001). Anglers often refer to these fishes as "redeyes" because of the conspicuous red pigment in their iris or "goggle eyes" because of their relatively large and conspicuous eyes (Etnier and Starnes 1993; Koppelman *et al.* 2000).

Generic characteristics: Moderately compressed, elongate body, depth <0.5 of SL; compressed when young, becoming thicker as adults. Large oblique mouth, lower jaw slightly projecting, supramaxilla large (≤2 times maxilla length), upper jaw extending under eye pupil. Black or dusky oblique teardrop; prominent, large eye (≥0.25 of head length) with red iris. No bright red, orange, blue, or green colors. Young camouflaged with large, irregularly shaped, dark blotches alternating with lighter areas on body. Young and adults capable of rapid chameleon-like changes in pigmentation, providing effective camouflage under varying light and background conditions (Viosca 1936; Petrimoulx 1984; Noltie and Keenleyside 1987b). Opercle with two flat projections; dusky to dark opercular spot with light edge. Preopercle posterior margin variable in degree and kind of serrations. Dorsal, caudal, and anal fins with dusky spots and brown wavy lines. Long dorsal fin, usually 11 or 12 spines, 10 to 12 rays, 22 or 23 total; and moderate anal fin, usually 6 spines, 10 or 11 rays, 16 or 17 total. Dorsal fin base about 1.7 to 2.0 times longer than anal fin base. Dorsal fin continuous with a shallow gap between spines and rays. Short, rounded pectoral fin. Emarginate caudal fin. Moderately long gill rakers, 12 to 16. Ctenoid scales. Branchiostegal rays, usually 6; pectoral rays, 14 or 15; vertebrae, 31 (13 + 18). Complete lateral line. Teeth on endopterygoid, ectopterygoid, palatine (villiform), and glossohyal (tongue, one or two circular patches) bones (Bailey 1938; Cashner 1974; Page and Burr 1991; Mabee 1993; Boschung and Mayden 2004).

Similar species: The warmouth has somewhat similar overall body shape and body mottling but has only three anal spines and dark lines radiating from the eyes (Page and Burr 1991).

13.4.1 Ambloplites ariommus *Viosca*

13.4.1.1 Shadow bass

Characteristics: See generic account for general characteristics. Relatively small, compressed, and deepest-bodied member of genus; body depth usually >0.42 of SL. Eye large, diameter typically >0.30 of head length. The pattern of dark blotches alternating with lighter areas on body in young is retained in adults, so that adults and young resemble the appearance of young *A. rupestris*. Preopercle sharply serrate to weakly crenate to entire at the angle. Dorsal fin elements, (20)22 to 23(24); anal fin elements, (15)16 or 17(18). Cheeks fully scaled with large, exposed scales. Cheek scale rows, (5)6 or 7(8); lateral line scales, (34)38 to 43(45); scale rows above lateral line, (5)6 or 7(8); scale rows below lateral line, (11)13 to 15(16); diagonal scale rows, (18)22 or 23(24); and breast scale rows, (13)16 to 18(20). One circular patch of teeth on tongue (Cashner 1974; Cashner and Suttkus 1977; Page and Burr 1991).

Size and age: Typically reach 40 to 120 mm TL at age 1. Large individuals measure 160 to 203 mm TL, rarely exceed 340 g, and reach age 6+ to 9+ (maximum 220 mm TL); Missouri and Arkansas populations can apparently reach larger sizes (at least 254 mm TL) than other populations (Viosca 1936; Robison and Buchanan 1984; Page and Burr 1991; Pflieger 1997; C. S. Schieble, University of New Orleans, personal communication). World angling record, 820 g, Arkansas (IGFA 2006). Females may outlive males, and males slightly exceed females in average maximum size and weight, but growth curves for the sexes are similar (C. S. Schieble, University of New Orleans, personal communication).

Coloration: Light green to brown on sides with irregular marbling of brown or gray dark blotches alternating with lighter areas, blotches often joined dorsally to form saddles. Scales on sides bear a dark, triangular spot at the base (apex forward), producing a pattern of longitudinal lines that run through but are often obscured by the light and dark pigmented areas. Lower sides and belly transitioning to straw color (Viosca 1936; Cashner 1974; Page and Burr 1991). Large breeding males have a distinct darkening of the membranes in the pelvic and anal fins from the fin tips to the base and distinct black, threadlike filaments on their pelvic fins. These filaments are yellow to white in females (C. S. Schieble, University of New Orleans, personal communication).

Native range: The range of the shadow bass is disjunct. The species occupies Gulf Slope drainages from the Apalachicola River west to the lower Mississippi River, including the Mobile Basin, and also occurs in the Red, Ouachita, Arkansas, St. Francis, and Black rivers (Page and Burr 1991).

Habitat: The shadow bass inhabits gravel, sand, and mud-bottomed creeks and small to medium rivers with low levels of turbidity and sedimentation. The species is almost always associated with pools and cover of boulders, logs, log complexes, or rootwads; water willow or other aquatic vegetation in shallow water often harbors young-of-the-year (Probst *et al.* 1984; McClendon and Rabeni 1987; Page and Burr 1991; Pflieger 1997, reported as rock bass; C. S. Schieble, University of New Orleans, personal communication). In a large-scale tagging study (Funk 1957), shadow bass (reported as rock bass) were regarded as sedentary, but 48% and 31% of recaptured individuals moved at least 1.6 km from the original point of tagging in the Black and Current rivers, Missouri, respectively. Measures of biomass and fish size indicated that adult shadow bass emigrated from the Current River to a large near-constant temperature spring (13.5°C) during cold winter months when river temperatures dropped below the spring temperatures. Individuals reentered the river during warm periods when river temperatures exceeded spring temperatures. During high use of the spring in cold periods, shadow bass in the spring had significantly higher relative stomach fullness and larger eggs than conspecifics in the river, suggesting that an energy subsidy was conferred on fishes that used the spring seasonally (Peterson and Rabeni 1996, reported as rock bass).

Food: The shadow bass is primarily a benthic feeder. An extensive diet study in Missouri indicated that crayfish were by far the most important prey item in shadow bass >100 mm TL. Young-of-the-year initially relied on invertebrates, particularly chironomids and mayflies as prey, but began consuming crayfish at about 25 mm TL and increased consumption with growth. About 70% of usable energy of adult shadow bass was derived from consumption of crayfish. Shadow bass consumed crayfish species in proportion to their abundance in the river, were size selective for crayfish 30 to 44 mm in length, and showed no seasonal shifts in diet. Fish, primarily stonerollers, and other invertebrates, particularly mayflies and stoneflies, were additional, but less important, adult diet items (Probst *et al.* 1984; Rabeni 1992, reported as rock bass). A limited analysis of shadow bass diets in a small, sand-bottomed Gulf Coastal Plain stream in Louisiana indicated high consumption of benthic fish prey (e.g., darters, madtom catfish, shiners) and insects (e.g., dragonflies, stoneflies, caddisflies) but limited predation on crayfish (Viosca 1936). Diel activity and feeding studies are unavailable, but the absence of shadow bass at night from their daytime haunts suggests a nocturnal component in activity and perhaps foraging (or at least a nocturnal shift in habitat use) (Probst *et al.* 1984).

Reproduction: Maturity is reached at age 1+ and a minimum size of 87 mm TL in females and 108 mm TL in males (C. S. Schieble, University of New Orleans, personal communication). Nest building has not been described, but an extensive examination of reproductive biology is available for southern populations in Lake Pontchartrain, Pearl River, and Mississippi River tributaries (C. S. Schieble, University of New Orleans, personal communication). Based on ovarian condition and ovary to body weight ratios, southern populations have a protracted spawning period extending from January or February to May or June, corresponding to water temperatures ranging from 15 to 26°C. Peak ovarian condition occurs at about 23°C. Mature ovarian eggs average 0.98 mm diameter (range, 0.56–1.7 mm), suggesting a somewhat smaller average mature ova size than in rock bass, but maximum sizes are comparable (Gross and Nowell 1980). Two size classes of vitellogenic ova are reported in mature females, and these are present from January through May, suggesting production of multiple batches of eggs. At a mean size of about 120 mm SL, a female can potentially produce 1311 mature eggs (range: 161 eggs at 85 mm SL to 4113 eggs at 156 mm SL) in a single spawning event. Peak female ovary to body weight ratios average 4.1% in February and March and 2.7% in March through May. Female ovary to body weight ratios, mean total ova, and mean ova diameters decrease substantially in June and subsequent months (C. S. Schieble, University of New Orleans, personal communication).

Nest associates: None known.

Freshwater mussel host: None documented, but see account on *A. constellatus*.

Conservation status: The shadow bass appears to be secure throughout its range (Warren *et al.* 2000), but is considered vulnerable in Louisiana (NatureServe 2006) where it is confined to the southeastern portion of the state. Increased sedimentation and turbidity in formerly clear, relatively fast-flowing Gulf Coastal Plain and Mississippi Alluvial Valley streams could and likely have reduced available habitat for this species (Pflieger 1997; C. S. Schieble, University of New Orleans, personal communication).

Similar species: Color pattern of sides of adult Ozark bass and rock bass (>100 mm TL) are irregularly arranged freckles or rows of blackish spots, lacking the usually conspicuous, alternating light and dark blotches of adult shadow bass. Juveniles of all three species are similarly patterned (Pflieger 1997).

Systematic notes: Patterns of differentiation in the Ozark populations of *A. ariommus* and its sister species, *A. rupestris*, can render identification difficult, irrespective of whether morphological criteria or allozyme-derived genetic data are used. Some suggest that the patterns of differentiation indicate a north-to-south cline between *A. rupestris* and Ozarkian *A. ariommus* populations that are indicative of conspecificity, but the observed patterns are confounded by known or suspected introductions of both species into various drainages in the region. For example, populations of *Ambloplites* in the Gasconade River and Charette Creek (both Missouri River drainage) display allozyme-derived genetic distances intermediate between *A. rupestris* and *A. ariommus*, which are likely attributable to past introductions (Koppelman *et al.* 2000). Even in naturally occurring populations, intermediacy is not positive proof of conspecificity of *A. rupestris* and *A. ariommus* because long-term evolutionary retention of ancestral polymorphisms after divergence of sister species is common in centrarchids (Near *et al.* 2005). Further, morphological differences between the two species in the Ozarks are supported (e.g., cheek and breast scales, adult color patterns) (Koppelman *et al.* 2000). At this time, field identification of *A. ariommus* in the Ozarks appears to be best accomplished on the basis of adult body coloration, body depth to length ratio, aspects of squamation, and geography (Pflieger 1997; Koppelman *et al.* 2000). Notwithstanding the Ozarkian populations, extensive morphological comparisons and limited population sampling of allozymes indicate that *A. ariommus* is polytypic. Populations in drainages of the Florida Panhandle and perhaps the Mobile Basin may be distinct (Cashner 1974; Koppelman *et al.* 2000), but resolution of the nature of the differentiation awaits a rangewide phylogeographic analysis of the species.

Importance to humans: The shadow bass has many desirable qualities as a sport fish although the relatively small maximum size limits angler interest in some parts of its range. The species readily takes a lure or natural baits and is a popular catch for anglers using ultralight gear or fly rods in streams and rivers of the Coastal Plain of Mississippi and the Ozark and Ouachita Mountains of Missouri and Arkansas (Robison and Buchanan 1984; Probst *et al.* 1984; Ross 2001). Creel surveys in the Pascagoula and Pearl rivers of Mississippi indicated that shadow bass constituted 1% and 0.6% of the total catch by weight, respectively (Ross 2001). The flavor and texture of the flesh of the shadow bass is similar to other centrarchids such as spotted bass and bluegill (Viosca 1936).

13.4.2 Ambloplites cavifrons *Cope*

13.4.2.1 Roanoke bass

Characteristics: See generic account for general characteristics. Relatively large, elongate body; body depth >0.41 of SL. Eye large, diameter about 0.25 of head length. Body pattern similar to that of *A. rupestris* but with freckled pattern (scattered, dark brown spots) on side of body and head. Adults with unique color pattern of numerous iridescent gold to white spots on upper body and head. Preopercle strongly serrate at the angle. Dorsal fin elements, (22)23(24); anal fin elements, (16)17(18). Cheeks naked or incompletely scaled with small, deeply imbedded scales. Lateral line scales, (39)42 to 46(49); scale rows above lateral line, (8)9 or 10(12); scale rows below lateral line, (13)14 or 15(16); diagonal scale rows, 23 to 26(27); and breast scale rows, (26)30 to 34(36). One or two oval patches of teeth on tongue (Bailey 1938; Cashner 1974; Cashner and Jenkins 1982; Page and Burr 1991; Mabee 1993).

Size and age: Typically reach 42 to 89 mm TL at age 1. Large individuals measure 250 to 296 mm TL, weigh 770 g, and reach age 4+ to 9+ (355 mm TL) (Smith 1971; Carlander 1977; Petrimoulx 1983; Jenkins and Burkhead 1994). World angling record, 620 g, Virginia (IGFA 2006). State records in Virginia and North Carolina are 1.12 and 1.13 kg, respectively. The Roanoke bass is the largest species in the genus with many plausible historical accounts of individuals weighing >1.0 kg (Jenkins and Burkhead 1994).

Coloration: Numerous iridescent gold to white spots on upper side of body and head. Ground colors variable, ranging from olive to tan to black to cream or blends of lighter and darker shades. Lateral pattern may consist of parallel rows of black spots, formed by scales darkened at bases, producing a lined pattern or indistinct dark and light blotches. Sides transition to white to bronze on breast and belly. All fins with some degree of yellow pigment, but median fins tend to be more olive and may be mottled or barred. Membranes of anal fin of breeding males dusky to dark but lack dark marginal band (Cashner 1974; Cashner and Jenkins 1982; Page and Burr 1991). Sexual dimorphism in color is minimal, but during nest guarding and spawning, the male darkens intensively and the pale spots become more evident (Petrimoulx 1984).

Native range: The Roanoke bass is endemic to the Neuse, Tar, Roanoke, and Chowan river drainages, North Carolina, and Virginia (Page and Burr 1991).

Habitat: The Roanoke bass occurs across a broad range of stream types in the upper Coastal Plain, Piedmont, Blue Ridge, and Ridge and Valley. The species is most common in flowing, rocky, and sandy creeks and small to medium rivers above the Fall Line, where it is often associated with deep runs. Roanoke bass appear to frequent faster currents than congeners (Smith 1971; Petrimoulx 1983; Jenkins and Burkhead 1994).

Food: The Roanoke bass is primarily a benthic feeder. Crayfish are the most important prey item for adults (>150 mm TL), augmented by small fish (e.g., darters, catfish, shiners) and various aquatic insects, particularly mayflies and caddisflies (Smith 1969, 1971; McBride *et al.* 1982; Petrimoulx 1983). Fish are less important in the diet in spring than in summer or fall, but overall, 75% of the food volume of adults consists of crayfishes, and the remaining 25% is primarily fishes (Petrimoulx 1983). Young fish (<100 mm TL) transition at 100 to 150 mm TL from a diet of mayflies, amphipods, and other small invertebrates to one predominated by crayfish, mayflies, and small fish. A high frequency of river weed (*Podostemum* sp.) and associated invertebrates in stomachs of Roanoke bass suggests that foraging occurs in areas of considerable current (McBride *et al.* 1982; Jenkins and Burkhead 1994).

Reproduction: Matures at age 2+ if a minimum size of 150 mm TL and 75 to 100 g body weight is reached (Smith 1971; Petrimoulx 1983). Based on ovarian condition and spawning observations, Roanoke bass spawn in May and June (perhaps as late as early July) at water temperatures of 20 to <25°C; postreproductive females first appear in samples in late July (Smith 1969, 1971; Petrimoulx 1983, 1984). Males (280–330 mm TL) initiated and completed nest building in 1 day as water temperatures approached 20°C in a hatchery pond in Virginia (Petrimoulx 1984). Substrate preparation was minimal, except that the guardian male removed snails and pebbles from the center of the nest by mouth and expelled them outside the nest; fanning, nest sweeping, or plant uprooting was never observed. The firm substrate of the pond may have limited the need for extensive nest preparation. Nests are solitary (≥1.3 m apart), 305 to 330 mm in diameter, 25 to 75 mm deep, at water depths of 30 to 60 cm, and excavated in gravel (<2.5 cm diameter) substrates if available (Smith 1969; Petrimoulx 1983). The male aggressively drives females away from the nest, but after about 45 minutes, when the female refuses to be driven off, the pair circles the nest, and spawning ensues with the male (in a central position) and female (outside position) in a broadside, face-to-face position. Spawning with each female lasts about 2.5 hours. In the observation pond, males spawned with two females simultaneously, but this may reflect low numbers of guardian males in the observation pond (Petrimoulx 1984). Mature ovarian eggs range from 1.3 to 2.0 mm in diameter (Smith 1969) and are among the largest reported for centrarchids. Two size classes of maturing ova are reported in females (vitellogenic and mature), suggesting two potential batches of eggs (Smith 1969; Petrimoulx 1983). In a North Carolina pond, the occurrence of two size classes of young-of-the-year also suggested at least two spawnings (Smith 1969), but renesting was not observed in the Virginia pond (Petrimoulx 1984). The relationship between total number of maturing ova (Y) and TL (X) is described by the linear function $Y = -3937.1 + 36.7$ TL ($n = 16$, $R^2 = 0.70$, equation from Petrimoulx 1983). At a median size of about 193 mm TL, a female can potentially produce 3256 vitellogenic and mature eggs (range: 2440 eggs at 136 mm TL to 6476 eggs at 250 mm TL). At about 20°C, eggs hatch in 2 to 3 days, larvae reach swim-up 2 to 3 days later, and larvae disperse from the nest over a 3- to 4-day period. The male guards the nest until larvae reach the swim-up stage, gradually reducing holding time over the nest as larvae disperse (Petrimoulx 1984). Young Roanoke bass are apparently extremely wary and seek cover in thick vegetation (Smith 1969, 1971; Petrimoulx 1984).

Nest associates: None known.

Freshwater mussel host: None known.

Conservation status: The Roanoke bass is considered vulnerable throughout its range (Warren *et al.* 2000; NatureServe 2006). In Virginia, the species is generally rare, and most extant populations are small. In North Carolina, the species is sparsely distributed but locally common (Smith 1969; Jenkins and Burkhead 1994). The Roanoke bass has been extirpated from portions of its former range (e.g., upper Roanoke River), and many populations appear to be persisting in marginal habitats where recruitment is poor (Petrimoulx 1983; Jenkins and Burkhead 1994). Losses and declines of populations are attributed to interactions with introduced rock bass, habitat degradation, and impoundments (Cashner and Jenkins 1982; Jenkins and Burkhead 1994). Establishment of additional populations by stocking in heavily silted streams had no apparent success in Virginia or North Carolina, but carefully planned stocking in suitable, high-quality habitats lacking potential nonnative competitors (e.g., rock bass, spotted bass) might produce additional populations (McBride *et al.* 1982; Jenkins and Burkhead 1994).

Similar species: The rock bass has cheeks that are conspicuously scaled with relatively large scales that are only slightly to moderately embedded; the body lacks distinct, round pale spots; and the anal fin is marked by a dusky or black edge that contrasts with the rest of the fin. In the Roanoke bass the cheek is unscaled or partially scaled with tiny deeply embedded scales; the body is marked with distinct, round pale spots; and a dark margin on the anal fin is usually absent, rarely slightly developed, but never distinctly contrasting with the rest of the fin (Cashner and Jenkins 1982; Jenkins and Burkhead 1994).

Systematic notes: *Ambloplites cavifrons* forms a sister pair with *A. constellatus* (Near *et al.* 2004, 2005). Until the late twentieth century *A. cavifrons* was often considered a subspecies of *A. rupestris* and was not differentiated from that widespread species by fisheries agencies. Cashner and Jenkins (1982) provided a clear morphological diagnosis of *A. cavifrons*, delimited the restricted range, reviewed the confused taxonomic history and resulting repeated stockings of *A. rupestris* in rivers and streams with native *A. cavifrons*, and provided morphological evidence of extremely limited hybridization of nonnative *A. rupestris* with native *A. cavifrons*. Mitochondrial and nuclear DNA analyses provide further evidence of the distinctiveness of *A. cavifrons* from congeners and its relatively distant evolutionary relationship to *A. rupestris* (Roe *et al.* 2002; Near *et al.* 2004, 2005).

Importance to humans: Although long unrecognized as distinct among *Ambloplites*, the Roanoke bass possesses qualities of a first-class sport fish. The species is the largest member of the genus, is regionally unique, and is highly palatable (Jenkins and Burkhead 1994). A review of anglers' catches (1964–1977, 1983) revealed that the majority of the Virginia citations for trophy *Ambloplites* (species not distinguished, 0.45 kg, 304 mm TL) were almost certainly Roanoke bass (Jenkins and Burkhead 1994). The sport fishery for the Roanoke bass is specialized, but the species is ardently sought by the few anglers in Virginia and North Carolina knowing where and how to fish for it (Smith 1969; Jenkins and Burkhead 1994). Increased emphasis on developing the sports fishery for this unique, range-restricted fish would diffuse knowledge of the species among anglers and, in turn, enhance its chances for long-term viability.

13.4.3 Ambloplites constellatus *Cashner and Suttkus*

13.4.3.1 Ozark bass

Characteristics: See generic account for general characteristics. Relatively large, elongate body, depth usually <0.42 of SL. Eye large, diameter ≤0.27 of head length. Body pattern similar to that of *A. rupestris* but with freckling (scattered dark brown spots) on side of body and head. Preopercle strongly serrate to weakly crenate at the angle. Dorsal fin elements, (22)23(24); anal fin elements, (15)17(18). Cheeks fully scaled with large, exposed scales. Cheek scale rows, (6)9(11); lateral line scales, (38)43 or 44(48); scale rows above lateral line, (6)8 or 9(10); scale rows below lateral line, (11)12 or 13(14); diagonal scale rows, (21)22 to 24; and breast scale rows, (20)22. One circular patch of teeth on tongue (Cashner 1974; Cashner and Suttkus 1977; Page and Burr 1991).

Size and age: Typically reaches 41 mm TL at age 1. Large individuals measure 180 to 213 mm TL and reach age 6+ to 11+ (maximum 259 mm TL) (Cashner and Suttkus 1977; Page and Burr 1991; Pflieger 1997). World angling record, 450 g, Arkansas (IGFA 2006). State record in Arkansas, 681 g (AGFC 2007).

Coloration: General coloration similar to that of shadow bass and rock bass, but ground color of olive to tan above and below the lateral line is more uniform on the body and among individuals. Sides of body, cheek, opercle, and preopercle are dominated by a freckled pattern of irregularly arranged dark spots. In a lateral scale row, one to three scales are darkened at the anterior base and followed by a series of scales lacking the dark spots, producing the freckled pattern. On the body, the freckled pattern is most evident below the lateral line. Above the lateral line, four or five saddle-like blotches may be visible, but these are never dark enough to obscure the freckling or spotted pattern on the scales (Cashner and Suttkus 1977; Page and Burr 1991). Fins usually olive green, and no black marginal band develops on the anal fin. Sexual dimorphism in color is minimal, but males become nearly black and females grey during courtship and spawning (Walters *et al.* 2000).

Native range: The Ozark bass is endemic to the upper White River of Missouri and Arkansas. The species drops almost completely out of the White River fauna at the physiographic border between the Ozark Plateau and the Mississippi Alluvial Valley. Isolated populations in the upper Osage River may be the result of introduction (Pflieger 1997; Koppelman *et al.* 2000).

Habitat: The Ozark bass is abundant in clear, rocky pools of upland creeks and small to medium rivers in the White River drainage of the Ozark Plateau. The species also occurs in reservoirs. Ozark bass are often associated with cover of banks, boulders, or logs usually located away from the swiftest main channel currents (Cashner and Suttkus 1977; Robison and Buchanan 1984; Pflieger 1997).

Food: The food of the Ozark bass has not been detailed, but the diet is likely similar to that of the rock bass and shadow bass.

Reproduction: Knowledge of the reproductive biology of the Ozark bass is limited to a published account detailing aspects of nest sites and nesting chronology over two spawning seasons and describing behaviors of a single spawning pair in the Buffalo River, Arkansas (Walters *et al.* 2000). Asynchronous egg deposition and male nest guarding occurred over 4- to 5-week periods from mid-May to mid-June at water temperatures of 17 to 23.5°C. Nests were located in gravel and cobble substrates at depths of 0.5 to 2.9 m, and guarded by males ranging in size from 150 to 230 mm TL. Most nests (>74%) were <1 m from cover and were usually downstream of cover (e.g., boulders, logs). The majority of small nest-guarding males (<200 mm TL) were observed more than 2 weeks after initiation of spawning, but significant correlations of size of nest-guarding males and time since the beginning of spawning were not detected. During courtship, the male rarely directed or pushed the female into the nest; both sexes waved their soft dorsal, caudal, and pectoral fins almost constantly while keeping the spiny dorsal fin flat. Before each egg deposition, the male and female pair circled the nest several times, the female sometimes over the male and the male occasionally nipping the female near the caudal peduncle. Spawning ensued, with the pair dropping to the nest with the male (usually in a central position) and female (usually outside position) in a broadside, face-to-face position over the nest. Eighty-eight spawning bouts occurred in 2 hours, the pair drifting up from the nest between bouts. The female remained in or near the nest during this time. No postspawning aggression of the male toward the female was observed. A pair of Ozark bass were spawning at the same nest an hour later, but it is unknown if it was the same or another female. High water events were associated with renesting (nests with embryos), but new nests with embryos were found throughout the spawning season. At a mean temperature of 21°C, eggs hatched in ≥5 days, and larvae remained in the nest for 5 to 7 days. Dispersing young were grey. During the nesting period, no Ozark bass fry were observed outside areas guarded by males. No young-of-the-year were observed in daytime snorkeling transects, and few were caught in daytime seine hauls. In contrast, young-of-the-year were caught in larger numbers in nighttime seine samples, suggesting nocturnal activity in Ozark bass young (Walters *et al.* 2000).

Nest associates: None known.

Freshwater mussel host: None documented, but Ozark bass populations co-occur with populations of *Villosa iris*. Gravid females of *V. iris* possess highly modified mantle lures that, at least in Ozarkian populations, mimic the appearance and movement of small crayfishes (Barnhart 2006). The prominence of crayfish in the diet of some *Ambloplites* and the host relationship of *A. rupestris* (and other large centrarchids) with *Villosa* spp., suggest a potentially fascinating, but as yet unstudied, host–fish relationship.

Conservation status: The Ozark bass is considered currently stable throughout its range (Warren *et al.* 2000; NatureServe 2006).

Similar species: Other species of *Ambloplites* lack the distinctive freckled pattern of Ozark bass (Cashner and Suttkus 1977; Page and Burr 1991). In addition, the body depths in adult shadow bass and rock bass (>150 mm SL) are typically >0.41 of the SL and <0.41 of SL in Ozark bass (Koppelman *et al.* 2000).

Systematic notes: Morphological and genetic evidence support long-term divergence and distinctiveness of *A. constellatus* from its sister species *A. cavifrons* and congeners (Cashner and Suttkus 1977; Koppelman *et al*. 2000; Near *et al*. 2004, 2005; Bolnick and Near 2005). Nevertheless, *A. constellatus* was not diagnosed and clearly differentiated from congeners until late in the twentieth century (Cashner and Suttkus 1977; Koppelman *et al*. 2000) and consequently was not recognized as distinct until relatively recently by fisheries managers. Early efforts to establish "rock bass" in Missouri and Arkansas streams involved brood stock taken from the upper White River, the range of *A. constellatus* (Cashner and Suttkus 1977; Robison and Buchanan 1984; Koppelman *et al*. 2000). These hatchery-based efforts were particularly intense in the 1930s and 1940s in Missouri (Pflieger 1997). Populations of *Ambloplites* in the Pomme de Terre and Sac rivers (upper Osage River, Missouri River drainage) are essentially identical to White River (Mississippi River drainage) populations of *A. constellatus* as evidenced by diagnostic allozyme loci, genetic distance, and phenotype (Cashner and Suttkus 1977; Pflieger 1997; Koppelman *et al*. 2000). In contrast, similar data suggest that the population in the Niangua River (middle Osage River) consists of non-F_1 hybrids between *A. constellatus* and *A. rupestris*. No historical records are available before 1960 of the *A. constellatus* occurring anywhere in the Osage River. Similarly, no records of *A. rupestris* in the Niangua River drainage are known before 1940, and first documented records for the lower Osage River are from 1964 (Pflieger 1997). The populations of these species now established in the Osage drainage are likely the result of introduction of both species (Pflieger 1997), which may have produced the spatially limited hybridization as evidenced in the Niangua River (Koppelman *et al*. 2000). Impoundments in the upper Osage River appear to have limited dispersal of *A. constellatus* in the system, producing the essentially isolated populations in the Sac and Pomme de Terre rivers.

Importance to humans: The Ozark bass is an abundant, popular, and sought-after sport fish in the upper White River of Missouri and Arkansas (Pflieger 1997; Koppelman *et al*. 2000).

13.4.4 **Ambloplites rupestris** *(Rafinesque)*

13.4.4.1 Rock bass

Characteristics: See generic account for general characteristics. Relatively large, robust, elongate body, depth variable, usually >0.41 of SL. Eye large, diameter ≤0.30 of head length. Adults with rows of brown-black spots along side, forming horizontal lines. Preopercle strongly serrate to weakly crenate, but always a few teeth at angle. Dorsal fin elements, (20)22(24); anal fin elements, (15)16(17). Cheeks fully scaled with large, exposed scales. Cheek scale rows, (5)8 or 9(10); lateral line scales, (35)38 to 42(47); scale rows above lateral line, (6)7 or 8(10); scale rows below lateral line, 12 to 14(16); diagonal scale rows, (19)20 to 24(25); and breast scale rows, (18)21 to 24(27). One circular patch of teeth on tongue (Bailey 1938; Keast and Webb 1966; Cashner 1974; Cashner and Suttkus 1977; Cashner and Jenkins 1982; Page and Burr 1991).

Size and age: Typically 42 to 102 mm TL at age 1. Large individuals measure 180 to 290 mm TL, weigh 200 to 454 g, and reach age 10+ to 14+ (maximum 430 mm TL) (Carlander 1977; Page and Burr 1991). World angling record, 1.36 kg, Pennsylvania and Ontario (IGFA 2006). Growth shows a latitudinal component in stream-dwelling rock bass such that northern populations grow more slowly than midlatitude populations. Among northern populations, maximum size and age of stream-dwelling rock bass are less than those of lake-dwelling rock bass, likely reflecting higher mortality in variable stream environments (Noltie 1988). In addition, subtle but significant differences occur in body form and relative fin sizes between northern lake and stream populations (Brinsmead and Fox 2002). Male rock bass can weigh more and reach longer lengths at age than females, but females can live longer (Ricker 1947; Carlander 1977; Noltie 1988).

Coloration: Ground color of olive to tan above and on sides, fading to lighter, white to bronze, on breast and belly; brassy yellow flecks on sides; however, general coloration and shading highly variable among individuals and populations. If not obscured by darkened ground color, sides of body are dominated by a spotted pattern of regularly arranged dark spots, forming dark, uninterrupted horizontal lines. In a lateral scale row, scales are darkened by a spot at the anterior base, producing the horizontal striping effect. Light areas on the scales above and below the spot often give the appearance of light horizontal lines and together produce a pattern of alternating light and dark lines. The lined pattern is most evident below the lateral line. Four or five dorsal saddles may be visible, extending down to or just below the lateral line. Anal fin has a distinct, black marginal band that extends across the spiny portion to the fifth or sixth soft ray (Cashner 1974;

Page and Burr 1991). Breeding males darken dramatically during the spawning period and develop black pigmentation along the spine and first ray of the pelvic fin or darken the entire fin (Cashner 1974; Gross and Nowell 1980; Noltie and Keenleyside 1987b). The pelvic fin margins of breeding female rock bass are yellowish white (Noltie 1985). External appearance of the genitalia (presence of the genital papillae in females) can be used as a reliable means of separating sexes during the breeding season (Noltie 1985).

Native range: The rock bass has the largest native range in the genus occurring in the St. Lawrence River-Great Lakes, Hudson Bay (Red River), and Mississippi River Basins. Rock bass have been widely introduced and are established in Atlantic Slope drainages as far south as the Roanoke River, Virginia, and in the Missouri and Arkansas River drainages. The species is also established in several western states (Page and Burr 1991; Fuller *et al.* 1999).

Habitat: The rock bass frequents cover in pools of creeks to small and medium rivers and the rocky and vegetated margins of lakes, being most common in silt-free rocky streams. Individuals in lakes frequent cover during the day (e.g., aquatic vegetation, rocky shelves, boulders) but disperse from these areas at night to feed (Keast 1977).

Rock bass movements of >161 km (Funk 1957; Storr *et al.* 1983) are documented and populations may or may not show restricted summer home ranges. In Lake Erie, recaptured, tagged rock bass were taken from ≤3 km of their original location (MacLean and Teleki 1977). In Lake Ontario, postspawning rock bass showed less dispersion along the shoreline than prespawning individuals, but the degree of dispersal in both periods (about 2 weeks on average) was large (average 3.5 km versus 11.2 km, respectively; Storr *et al.* 1983). Overall average movement from April to June in tributaries to Lake Ontario was 500 m/d and maximal hourly movement was 200 m/h (Gerber and Haynes 1988). Summer home range in an Indiana stream was estimated at about 66 linear meters (Gerking 1950), and seasonal, multiyear samples in Tennessee streams revealed that 90% of recaptured rock bass remained in the same 500-m segment, and more than 50% were within the same 100-m segment (Gatz and Adams 1994).

Some populations of rock bass migrate to wintering areas. In Lake Ontario, catches of tagged rock bass and dispersion models suggested movement from shoreline habitats to overwintering areas in deeper water (Storr *et al.* 1983), and littoral zone samples in Wisconsin lakes also indicated offshore movement in fall (Hatzenbeler *et al.* 2000). In small Virginia streams, fish in headwaters emigrated downstream in the fall, and in winter, fish used the deepest pools available (Pajak and Neves 1987). The presence of rock bass in a small North Carolina stream almost exclusively from autumn to spring over 10 years of sampling indicates that some populations migrate upstream to overwintering areas in fall and return downstream the following winter or spring (Grossman *et al.* 1995).

Rock bass are sensitive to acidification, but sensitivity varies among life stages. Faunal analyses of northern lakes, *in situ* tests in lakes, and laboratory tests indicate that rock bass are negatively affected at pH 4.5 to 5.5 (Rahel and Magnuson 1983; Magnuson *et al.* 1984; McCormick *et al.* 1989; Eaton *et al.* 1992). Rock bass embryos, but not larvae, survived in an experimentally acidified lake at pH 5.1, recruitment was greatly reduced at pH 5.6, and high adult mortality occurred at pH 4.7. In the laboratory, survival of embryos and larvae (to 7-day post hatching) decreased by 40 to 50% at pH 5.0 and was near zero at pH 4.5. Larval survival also showed a dose-correlated decrease with decreasing pH (7.0 to 5.0) and increased Al (<0.6 to 56 μg/l) (Eaton *et al.* 1992). In a related laboratory study, juvenile rock bass (5.3 g) osmoregulated and survived up to 30 days at pH ≥4.5 but lost osmoregulatory control at pH 4.0 and died in ≤29 days (McCormick *et al.* 1989).

Food: The rock bass is primarily a benthic feeder. Large invertebrates, such as crayfish, dragonfly nymphs, mayfly larvae, and caddisfly larvae are the primary diet items of adults (Keast and Welsh 1968; Keast 1977, 1985c; Johnson and Dropkin 1993; Roell and Orth 1993). In the New River, Virginia, where crayfish constitute more than 50% of the wet weight diet of individuals >100 mm TL, rock bass consume an estimated 31% of the annual production of crayfish of age 1 or 2 in the river (Roell and Orth 1993). Predation by rock bass is implicated in shifts in longitudinal distribution and species composition of juvenile crayfishes in headwaters of the New River, North Carolina (Fortino and Creed 2007). Small fish are taken during the second summer of life but contribute substantially to the diet only in larger adults (Keast 1977, 1985c; Elrod *et al.* 1981). Young-of-the-year feed heavily on cladocerans, isopods, amphipods, and chironomids; various aquatic insect larvae also contribute to the diet in the first summer (Keast 1977, 1980; George and Hadley 1979). The eyes of the rock bass are well equipped to allow successful capture of invertebrates in dimly lit bottom habitats. Lens quality increases until age 5, the distance of contraction and relaxation is high (≤28 diopters), and the ability to retain focus on approaching a target (93 diopters/s) is almost an order of magnitude greater than that reported for humans (Sivak 1973, 1990; Sivak and

Howland 1973). The relatively large retina contains a temporal dorsal area of highest double cone densities that correlates with ability to detect prey below the horizontal plane (Williamson and Keast 1988). In the spring, diel studies indicate about equal feeding from mid-morning until noon and again from late afternoon to midnight (Keast and Welsh 1968) and in the fall, low levels of feeding during daylight hours with peak feeding between 2000 and 0400 hours (Johnson and Dropkin 1993). Diel movement of radio-tagged individuals in summer in Lake Ontario suggested higher diurnal than nocturnal activity. Activity was highest from 0900 to 2000 hours, decreasing substantially by 2200 hours; no diel patterns in activity were discerned in fish in tributaries to the lake (Gerber and Haynes 1988). Underwater observation in two lakes revealed an intensification of activity and feeding 30 minutes to 2 hours before darkness. During that time, large rock bass that aggregated in daytime resting areas near cover (1–8 m depth) moved as individuals or small groups into shallow water (Emery 1973; Helfman 1981). After darkness, individuals continued to be active in one lake, but in the other, individuals settled into and rested on rocks, logs, or plants. Underwater observations in a river indicated that rock bass are more active at night, tending to move from daytime cover to presumably feed in riffle and run habitats (Lobb and Orth 1991). Rock bass show active shoaling preferences for conspecifics and benefit from social enhancement of foraging (Brown and Colgan 1986; Templeton 1987; Brown and Laland 2003).

Reproduction: Age at maturity is highly variable ranging from age 2+ to 7+ or even 9+ (about 125–150 mm TL) (Gross and Nowell 1980; Noltie 1988). Rock bass along the northern shore of Lake Erie make a 35- to 40-km spring migration to spawning grounds in an inner bay (MacLean and Teleki 1977), and other northern populations regularly ascend streams for spawning, moving up to 11 km/d (average 2.9 km/d), after overwintering in deeper waters (Noltie and Keenleyside 1987a; Gerber and Haynes 1988). Nest-site fidelity is high in some populations. Over 85% of recaptured rock bass in a northern lake nested within 50 m of their nest site in the previous year (Sabat 1994a), but in a Lake Ontario study, only 3 of 25 rock bass tagged during a spawning season and recaptured during subsequent spawning seasons were taken at the same site. The others were recaptured 28 to 185 km from the original tagging site (Storr *et al.* 1983). Males initiate nest building in late spring or early summer at temperatures as low as 14.0°C, and spawning temperatures range from about 18 to 23°C. Nests are circular in lakes (average 27 cm diameter) and elliptical in streams (37 cm wide, 43 cm long), about 5 to 7 cm deep, at water depths of 50 to 70 cm, and are typically excavated over coarse substrates (0.9–2.4 cm diameter). The spawning period can last from 6 to 8 weeks, but most reproductive activity occurs over a 3- to 4-week period; spawning tends to be synchronous in lakes and asynchronous in streams (Gross and Nowell 1980; Noltie and Keenleyside 1987a; Sabat 1994a). Large, older male rock bass (>100 g) nest and spawn 2 to 4 weeks earlier than smaller, younger males, and male size and number of eggs acquired are correlated positively, presumably reflecting female choice of mates (Noltie and Keenleyside 1987a; Sabat 1994b). In streams, nests are spaced widely (average 7.7 m apart) and near cover, but in lakes, nests are more closely spaced (average 1.6 m apart) with no apparent relation to cover (Gross and Nowell 1980; Noltie and Keenleyside 1987a). Circling of the nest by the male and female before spawning may occur for several minutes, or spawning may proceed without circling (Gross and Nowell 1980; Noltie and Keenleyside 1987b). A complete spawning bout can last 3.5 hours (average 2 h) and on average involves 120 separate egg releases (about 3–5 eggs per release); after each release, the female is often aggressively driven from the nest by the male for periods of 15 seconds to several minutes before returning for another bout (Gross and Nowell 1980). In synchronously spawning lake populations, females may spawn with more than one male, and males may spawn serially with alternating females (Gross and Nowell 1980), but in asynchronously nesting stream populations, males and females appear to be nearly monogamous (Noltie and Keenleyside 1987a,b). Mature ovarian eggs range from about 1.2 to 2.1 mm in diameter. Two size classes of ova are reported in females (modes, 1.65 mm and 0.44 mm) (Gross and Nowell 1980). Temporal changes in frequencies of egg diameter classes in lake-dwelling rock bass are coincident with spawning of two batches separated by a 16-day interval (Gross and Nowell 1980), and up to three discrete egg-laying bouts may occur over a 6- to 8-week period (Sabat 1994a,b). Information on numbers of mature ova in spawning-ready females is unavailable, but total fecundity is related positively to length (Carlander 1977). Based on observations of ovipositing females and numbers of larvae in nests, females appear to deposit about 400 to 500 eggs in a spawning bout (Gross and Nowell 1980). At a mean temperature of 22.5°C (range 16–22°C), eggs hatch in 5 days, and larvae disperse from nests 9 days later. Large older males may renest one or more times over the breeding season (Gross and Nowell 1980; Noltie and Keenleyside 1986; Sabat 1994b). Flooding, predation, and fouling of nests by algae are major causes of brood failure in stream-dwelling populations, resulting in frequent renesting attempts by males (Noltie and Keenleyside 1986). Parental males fan the eggs and defend the embryos and larvae (344 to 1758/nest) for an average of 14 days, abandoning the nest as the fry disperse (Carbine 1939; Gross and Nowell 1980; Noltie and Keenleyside 1986). Body weight of males can decline by 5 to 24% during the parental care period (Noltie and Keenleyside 1986; Sabat 1994a). Increased weight loss of parental male rock bass reduced probability of recapture in subsequent years (Sabat 1994a), suggesting a link between weight loss due to nesting and subsequent survivability of males. Free-swimming rock bass fry show no swarming behavior, begin agonistic behaviors sooner and at a smaller size (36 days post swim-up, 21 mm TL) than either *Lepomis* or *Micropterus*, and begin predator avoidance responses at 1 week of age (Brown 1984; Brown and Colgan 1985a).

Freshwater mussel host: Confirmed host to *Actinonaias ligamentina* (Lefevre and Curtis 1910), *Arcidens confragosus* (Surber 1913), *Pyganodon grandis, Utterbackia imbecillis* (Tucker 1928; Trdan and Hoeh 1982), *Strophitus undulatus* (Van Snik Gray *et al.* 2002), *V. iris* (Zale and Neves 1982, as *Villosa nebulosa*; O'Connell and Neves 1999), and *Villosa taeniata* (Gordon *et al.* 1994). Putative host to *Amblema plicata*, *Epioblasma obliquata*, *Lampsilis reeveiana*, *Lasmigona holstonia*, *Ligumia recta*, *Pyganodon cataracta*, and *Villosa constricta* (unpublished sources in OSUDM 2006).

Conservation status: The rock bass is currently considered stable throughout its range (Warren *et al.* 2000; NatureServe 2006). Introduction of rock bass into northern lakes where it is not native is implicated in declines in littoral zone fishes with potentially severe consequences for native lake trout populations dependent on those fishes for forage (Vander Zanden *et al.* 1999).

Similar species: Other species of *Ambloplites*, except the Roanoke bass, lack the distinctive rows of spots of rock bass; the Roanoke bass has unscaled or partly scaled cheeks and iridescent gold to white spots on the upper side and head (Cashner and Jenkins 1982; Page and Burr 1991).

Systematic notes: See accounts on *A. ariommus, A. constellatus,* and *A. cavifrons.*

Importance to humans: Although underappreciated by many anglers, the rock bass is a feisty sport fish with firm, excellent-tasting flesh. As recently as the 1970s, rock bass contributed substantially to the commercial fishery and sport fishery catch in several Great Lakes (Scott and Crossman 1973; MacLean and Teleki 1977).

13.5 *Archoplites interruptus* (Girard)

13.5.0.1 Sacramento perch

Characteristics: Moderately compressed, deep but somewhat elongate body, depth about 0.4 of SL. Large, oblique mouth, lower jaw projecting, supramaxilla large ($\leq$2 times maxilla length), upper jaw extending under pupil of the eye. Opercle varies from two flat extensions to broadly rounded; dusky to dark opercular spot. Preopercle posterior margin sharply serrate. Long dorsal fin, 12 to 14 spines, 10 to 11 rays, 22 to 25 total; and moderate anal fin, 6 to 8 spines, 10 to 11 rays, 16 to 18 total. Dorsal fin base about twice as long as anal fin base. Dorsal fin continuous with shallow gap between spines and rays. Emarginate caudal fin. Rounded pectoral fins. Long, slender gill rakers, 25 to 30. Strongly ctenoid scales. Lateral line scales, 38 to 48; cheek scale rows, 6 to 9; branchiostegal rays, 7; pectoral rays, (13)14(15); vertebrae, 31(13 + 18). Teeth on entopterygoid, ectopterygoid, palatine (villiform), and glossohyal (tongue, two elongate patches) bones (Bailey 1938; Page and Burr 1991; Mabee 1993; Moyle 2002; C. M. Woodley, University of California-Davis, personal communication).

Size and age: Typically 60 to 130 mm TL at the end of year one, depending largely on food availability and water temperature (C. M. Woodley, University of California-Davis, personal communication). Large individuals measure 370 to 400 mm TL, weigh 1.2 kg, and age 9+ (maximum, 610–730 mm TL and 3.6 kg) (Page and Burr 1991; Moyle 2002). World angling record, 1.44 kg, California (IGFA 2006). Females grow faster, reach larger sizes, and live longer than males (Mathews 1962; Aceituno and Vanicek 1976; Moyle 2002).

Coloration: Olive brown above with 6 to 7 irregular dark bars on the upper side extending ventrally to the lateral line. Depending on habitat, varies from silver-green to purple sheen on mottled black and white side to silvery with dark barring; white ventrally. Breeding colors are variable. Males can be darker than females with purple opercula and a distinctive silvery spotting showing through the darker sides and can have a conspicuous darkened patch on top of their head; breeding females tend to be more uniform in color (Page and Burr 1991; Moyle 2002; C. M. Woodley, University of California-Davis, personal communication).

Native range: The Sacramento perch is the only centrarchid with a native range west of the Rocky Mountains, where it was common and often abundant historically throughout the Central Valley of California (San Joaquin-Sacramento rivers), the Pajaro and Salinas rivers, and Clear Lake at elevations below 100 m. Currently, the only population that represents continuous occupation within the native range persists in Alameda Creek (Moyle 2002), but that population is considered unstable, the last record being of a single individual taken in 1999 in Calveras Reservoir (P. Crain and C. M. Woodley, University of California-Davis, personal communication). The species was introduced extensively outside its native range in the western United States between the 1870s and 1960s as a potential sportfish (McCarraher and Gregory 1970; Fuller *et al.* 1999) but now occurs outside the native range only in lakes, reservoirs, and associated streams in California, Nevada, Utah, and Oregon. Few of these populations are considered stable (Moyle 2002; Schwartz and May 2004; P. Crain, R. Schwartz, and C. M. Woodley, University of California-Davis, personal communications).

Habitat: The Sacramento perch was formerly common in sloughs, slow-moving rivers, and lakes. The species often is associated with vegetation beds, which may be an essential habitat for young-of-the-year. Now, the species most commonly occurs in reservoirs and farm ponds. Because the original habitat was subject to extreme drought and flooding, Sacramento perch are notably tolerant of high turbidity, temperatures, alkalinity, chloride–sulfate salinity, and dissolved solids (Moyle 2002). Temperatures $\leq 30°C$ are readily tolerated (Moyle 2002). Recent work indicates the species is a cool-water centrarchid, with the preferred temperature ranging from 16 to 19°C; similarly, physiological optima appear to lie between 18 and 23°C (C. M. Woodley, University of California-Davis, personal communication). The species survived ≥ 12 months at pH >9 and maximal alkalinities >2000 mg/l in alklai lakes of Nebraska. Other centrarchids introduced in these habitats survived from a few hours to less than a month (McCarraher and Gregory 1970; McCarraher 1971). The species can reproduce in ponds with maximal pH and dissolved solids of 8.8 and 19,248 mg/l, respectively (Imler *et al.* 1975), and chloride–sulfate alkalinities of 17 ppt (McCarraher and Gregory 1970).

Food: The Sacramento perch is a sluggish, slow-stalking, highly opportunistic suction-feeding carnivore (Vinyard 1982; Moyle 2002). It feeds primarily by "inhaling" organisms off the bottom or aquatic plants and by capturing zooplankton, fish, or emerging insects in midwater (Moyle *et al.* 1974). The species has numerous, long gill rakers that likely play an important functional role in the extended (<90 mm TL) feeding on zooplankton and other microcrustaceans. Although slight peaks in foraging occur at dawn and dusk, Sacramento perch show no obvious diel feeding periodicity, feeding at all times of the day and night (Moyle *et al.* 1974; Moyle 2002). Large individuals (>90 mm TL) in an introduced population (Pyramid Lake, Nevada) switched almost exclusively to piscivory, but in many populations, microcrustaceans and aquatic insect larvae and pupae continue as important components of the adult diet (Moyle *et al.* 1974; Imler *et al.* 1975; Aceituno and Vanicek 1976).

Reproduction: Maturity is reached at age 2 to 3+ at a minimum size of about 120 mm fork length (FL). Spawning occurs at water temperatures of 18 to 29°C and can extend from March through early August with peaks in late May to early June (Murphy 1948; Mathews 1962; McCarraher and Gregory 1970; Aceituno and Vanicek 1976; Moyle 2002). Published accounts of reproductive behaviors are few, somewhat inconsistent, and based on limited observations. Although some observations suggested definite male territory defense (about 40 cm diameter) without preparation of the substrate, more recent extensive observations indicate male digging of nests with the caudal fin and subsequent defense of obvious cleared, depressions (C. M. Woodley, University of California-Davis, personal communication). Territories and nests are often associated with vegetation or filamentous algae beds in shallow water (20–50 cm deep) and over substrates of mud, clay, or rocks; rock piles or other cover may also attract spawning individuals (Murphy 1948; Mathews 1962, 1965; Aceituno and Vanicek 1976; Moyle 2002; C. M. Woodley, University of California-Davis, personal communication). Nest preparation may span several days (Moyle 2002). Some observed nests were arranged linearly along shorelines, but others were suggestive of colonies (Murphy 1948; Aceituno and Vanicek 1976; Moyle 2002). Tail quivering occurs in territorial males, a behavior which appears distinct from the nest sweeping behavior of other centrarchids (caudal sweeping, Miller 1963; Mathews 1965). The male remains stationary over the nest with the head down and pectoral fins out and rapidly oscillates the tail back and forth in small arcs, at 3 to 5 oscillations per second, ending with the head up and nearly perpendicular to the nest. After several seconds the male rests, then repeats the behavior, which intensifies during courtship and spawning. Territorial males repeatedly repulse approaching females (Mathews 1965). After repeated attempts to repulse the female (≤1 hour), the male swims stiffly to the ready female and nips at the vent (Moyle 2002). Pairs of Sacramento perch spend up to 30 minutes on the nest before spawning, during which time the male nips or nudges the female and both substrate bite, undulate, and contort their bodies, and jaw gape. Females may mate with more than one nesting male (Moyle 2002). In a natural setting, a male and female in the nest oriented broadside during spawning, but in opposite directions, unlike the head-to-head spawning position typical of other centrarchids. They made tight circles during gamete release as is typical of many centrarchids, but both the male and female tilted away from one another at the moment of release, another apparent departure from typical centrarchid gamete release (Mathews 1965; see also Bolnick and Miller 2006). Eggs are demersal, slightly adhesive, and upon deposition, adhere to surrounding vegetation or substrate in the bottom of the nest. Sacramento perch have among the smallest mature eggs among centrarchids (0.67 mm diameter) (Mathews 1962) and one of the highest batch fecundities among centrarchids (see *Centrarchus macropterus* and *Pomoxis*). Descriptive accounts indicate a unimodal distribution of mature or ripening ova sizes in mature females (Mathews 1962), suggesting release of a single batch of eggs. The relationship between number of mature eggs (Y) and TL (X) is described by the power function $Y = 0.0279X^{2.6148}$ ($n = 32$, $R^2 = 0.89$, data from Mathews 1962, FL converted to TL, see Aceituno and Vanicek 1976). At a mean size of 200 mm TL, a female can produce 29,003 mature eggs (range: 9820 eggs at 117 mm TL to 121,570 eggs at 330 mm TL, Mathews 1962). Hatching occurs in 51 hours and larval swim-up between 4 and 6 days at 22°C (Mathews 1962). From a single nest observation, male parental care is oft-cited as lasting only 3.5 days at water temperatures between 22 and 24°C, which is a short period of parental care relative to other centrarchids (Mathews 1965). More extensive observations at cooler water temperatures indicate that males stay at the nest for 5 to 7 days, apparently abandoning the nest only after larvae swim-up and move out of the nest area (Mathews 1962, 1965; C. M. Woodley, University of California-Davis, personal communication).

Nest associates: None known.

Freshwater mussel host: None known.

Conservation status: Although tolerant of a range of physicochemical conditions, the distribution and abundance of native populations of the Sacramento perch has declined gradually since the nineteenth century. Declines are attributed to habitat alteration, embryo predation, and interspecific competition, particularly from nonnative centrarchids, such as bluegill and black crappie (Murphy 1948; Aceituno and Nicola 1976; Vanicek 1980; Marchetti 1999; Moyle 2002). In experiments with limited food resources, growth was depressed and habitat use shifted in the Sacramento perch in the presence of the more aggressive, dominating bluegill (Marchetti 1999). Native populations in the Pajaro and Salinas rivers and Clear Lake (Lake County) are extirpated (Gobalet 1990; Moyle 2002; Schwartz and May 2004). Within their native range the species persists primarily in ponds, reservoirs, and recreational lakes into which they were introduced, often upstream of native habitat (Moyle 2002). The species is considered of special concern in California rather than endangered because a few introduced populations appear secure (e.g., Garrison Reservior, Utah; Crowley Reservoir, California). However, even in many introduction sites in California and elsewhere, the species is uncommon, extremely rare, or extirpated (Moyle 2002; P. Crain and C. M. Woodley, University of California-Davis, personal communications; see section on native range).

Similar species: The anal fin base of the white crappie and black crappie is about as long as the dorsal fin base, and the dorsal fin in these species has six to eight spines.

Systematic notes: *Archoplites interruptus* is sister to the genus *Ambloplites*, and the *Archoplites–Ambloplites* pair are sister to *Pomoxis* (Roe *et al*. 2002; Near *et al*. 2004, 2005). Fossil representatives of the genus *Archoplites* are widespread west of the continental divide in Miocene to Early Pleistocene deposits (e.g., Idaho, Washington, Oregon, Utah, Nevada, and California) (Miller and Smith 1967; Smith and Miller 1985; Minckley *et al*. 1986; McPhail and Lindsey 1986; Near *et al*. 2005). Two other species, both extinct, are congeners: *A. clarki* Smith and Miller, from Miocene lacustrine deposits in northern Idaho (Smith and Miller 1985) and *A. taylori* Miller and Smith, from Late Pliocene to Early Pleistocene lacustrine deposits in southwestern Idaho (Miller and Smith 1967; Smith and Patterson 1994). Meristic variation among populations of *A. interruptus* is low, but some differences in color pattern exist (Hopkirk 1973; Moyle 2002). The population in Clear Lake probably is genetically distinct because of long isolation from other populations (Moyle 2002).

Importance to humans: Historically, the Sacramento perch was one of the most common fishes caught by native peoples of California. In the late nineteenth century, 18,144 to 195,954 kg (40,000 to 432,000 lb) were sold annually in San Francisco (Gobalet and Jones 1995; Moyle 2002).

13.6 *Centrarchus macropterus* (Lacépède)

13.6.0.2 Flier

Characteristics: Deep, extremely compressed body, depth about half of SL. Small, supraterminal, oblique mouth, lower jaw projecting, supramaxilla moderate (2.1 to ≤3 times into length of maxilla), upper jaw not reaching past middle of eye. Eye large, diameter equal or greater than snout length. Large black teardrop. Interrupted rows of dark spots along the side. Juveniles (≤65 mm SL) with red-orange halo encircling black spot on posterior of soft dorsal fin. Opercle lacks flat extensions; opercular spot black. Preopercle posterior margin finely serrate. Long dorsal fin, 11 to 14 spines, 12 to 15 rays, 25 to 27 total; and long anal fin, 7 to 9 spines, 13 to 17 rays, 22 to 24 total. Dorsal fin base about 1.1 to 1.3 times longer than anal fin base. Spiny and soft dorsal fins continuous and smoothly rounded. Emarginate caudal fin. Long, pointed pectoral fin. Long, slender gill rakers, 30 to 40. Ctenoid scales. Lateral line scales 36 to 44; cheek scale rows, 4 to 7; branchiostegal rays, 7; pectoral rays, (12)13(14); vertebrae, 31(13 + 18). Teeth on entopterygoid, ectopterygoid, palatine (villiform), and glossohyal (tongue, two patches) bones (Bailey 1938; Page and Burr 1991; Mabee 1993; Jenkins and Burkhead 1994; Boschung and Mayden 2004).

Size and age: Typically reach 55 to 72 mm TL at age 1. Large individuals measure 210 mm TL, weigh 156 to 197 g, and reach age 7+ to 8+ (maximum 250–356 mm TL) (Conley 1966; Geaghan 1978; Etnier and Starnes 1993; Jenkins and Burkhead 1994; Pflieger 1997). World angling record, 560 g, Georgia and North Carolina (IGFA 2006). Females can reach larger sizes and live longer than males (Conley 1966; Geaghan and Huish 1981).

Coloration: Olive green to olive brown above; sides brassy yellow or silver with green and bronze flecks; rows of brown spots on sides forming horizontal lines. Brown-black spots on medial fins often form wavy bands or bars. Iris with vertical black bar continuing as tear drop. Young with four to five broad dark bars on side (Page and Burr 1991; Jenkins and Burkhead 1994; Pflieger 1997; Boschung and Mayden 2004).

Native range: The flier occurs primarily on the Coastal Plain from the Potomac River drainage, Maryland, to central Florida, and west to the Trinity River, Texas. The species penetrates the Mississippi Embayment to southern Illinois and southern Indiana, where it occurs above the Fall Line (Page and Burr 1991).

Habitat: The flier is a decidedly lowland species, inhabiting swamps, vegetated lakes, ponds, sloughs, and backwaters and pools of small creeks and small rivers. The species is usually associated with densely vegetated, clear waters (Page and Burr 1991; Jenkins and Burkhead 1994; Pflieger 1997; Boschung and Mayden 2004). Relative abundances were highest in hypoxic habitats in the Atchafalaya River Basin, Louisiana, where most fishes occurred in low relative abundances (Rutherford *et al.* 2001). The species also occurs in acid waters (pH 3.7 to 4.8), although growth appears to be diminished at low pH (Geaghan 1978); it is the most common sunfish in the acidic Okefenokee Swamp (Laerm and Freeman 1986). Movements of 12.7 km are documented, but ≥75% of individuals recaptured within 90 days of marking were found <200 m from their release site (Whitehurst 1981), suggesting fidelity to limited activity areas over extended periods. Increased movements occur in spring, presumably in association with spawning (Holder 1970; Whitehurst 1981).

Food: The flier is a primarily nocturnal feeder with feeding practically ceasing during daylight hours (Conley 1966). The diet varies considerably with size, but zooplanktivory is continued to relatively large sizes and is likely associated with the possession of numerous, long gill rakers. Young (<22 mm TL) feed exclusively on copepods. Small crustaceans (primarily copepods and cladocerans), augmented with aquatic insects, form the bulk of the diet of individuals <175 mm TL. At larger sizes, insects are of primary importance, but small fish (mainly young bluegills) and crustaceans are also taken (Chable 1947; Conley 1966; Geaghan 1978; Jenkins and Burkhead 1994; Pflieger 1997).

Reproduction: Maturity is reached at age 1+ and a minimum size of about 70 to 75 mm TL. Fliers are among the earliest, lowest temperature spawners in the family. The ovaries enlarge and continue developing in the fall and over winter (Conley 1966), which is likely an adaptation for early spawning. Nest building is initiated at 14°C and the brief 10- to 14-day spawning period begins at water temperatures of 17°C in March and April (Dickson 1949; Conley 1966; Pflieger 1997). Only a single anecdotal account of reproductive behaviors is available (Dickson 1949). The male establishes and defends a territory and prepares a typical, saucer-shaped depressional nest using his mouth and fins. Nesting occurs in shallow water (0.3–1.2 m depth) and is apparently colonial (2–15 closely spaced nests, similar to bluegill). Males remain relatively motionless over the nest and are quick to flee on approach and exceedingly slow to return to the nest (Dickson 1949). The male leads the female to the nest. On entering the nest, the female remains motionless in the nest as the male circles several times; biting is mutual during spawning. Females may mate with more than one nesting male (Dickson 1949). Eggs are demersal, adhesive, and golden yellow. Mature ovarian eggs are the smallest of all centrarchids (0.300–0.434 mm diameter) (Dickson 1949; Conley 1966), and size-adjusted batch fecundities are high for a centrarchid (see *Archoplites* and *Pomoxis*). Only one size class of maturing ova is reported in mature females, and postspawning females did not retain mature or maturing eggs (Conley 1966), suggesting production of a single batch of eggs. The relationship between number of mature eggs (Y) and TL (X) is described by the power function $Y = 0.0230X^{2.7525}$ ($n = 63$, $R^2 = 0.79$, data from Dickson 1949, Alabama; Conley 1966, Missouri). At a mean size of 114 mm TL, a female can produce 10,552 mature eggs (range: 4412 eggs at 70 mm TL to 48,254 eggs at 205 mm TL). Peak spawning female ovary to body weight ratios are among the highest of any centrarchid (see *Enneacanthus* and *Lepomis*), reaching 12.5% in early spring (Conley 1966). The tiny eggs suggest that the flier lies close to *Pomoxis* or *Archoplites* on the male parental care continuum (Gross and Sargent 1985). Hatching occurs in 7 to 8 days at about 19°C. One (or few) anecdotal observation suggested that the male leaves the nest and eggs before hatching (Dickson 1949), which, if true, is a notable departure from centrarchid male reproductive behavior. Detailed study of parental care and other aspects of the reproductive biology of the flier could provide insight into evolution of these traits in other Centrarchinae.

Nest associates: None known.

Freshwater mussel host: None known.

Conservation status: The flier appears to be secure where its lowland habitats are undisturbed (Warren *et al*. 2000) but its conservation is of concern at the periphery of its range (vulnerable, Illinois, Missouri, and Oklahoma; critically imperiled, Maryland) (NatureServe 2006).

Similar species: The white crappie and black crappie lack the dark teardrop and rows of spots on the sides and have 6 to 8 dorsal fin spines.

Systematic notes: *Centrarchus* is a monotypic genus that is basal to a clade comprised of the genera *Enneacanthus, Pomoxis, Archoplites*, and *Ambloplites* (Roe *et al*. 2002; Near *et al*. 2004, 2005). Comparative studies of variation across the range of *C. macropterus* are lacking.

Importance to humans: The flier is too small and localized in distribution to contribute to most sport fisheries. The species is a popular sport fish in the Okefenokee Swamp, where it makes up a considerable portion of the sunfish creel (Laerm and Freeman 1986). The flier rapidly seizes live or artificial bait and often leaps out of the water (hence, the name flier). The flesh is likened to that of bluegill (Dickson 1949).

13.7 *Enneacanthus* Gill

The genus *Enneacanthus* consists of a clade of three diminutive species in which *Enneacanthus chaetodon*, the blackbanded sunfish, is sister to *Enneacanthus gloriosus*, the bluespotted sunfish, and *Enneacanthus obesus*, the banded sunfish. *Enneacanthus* is sister to a clade comprised of the genera *Pomoxis, Archoplites*, and *Ambloplites* (Near *et al*. 2004, 2005). The genus is distributed in the lower Piedmont and Coastal Plain drainages of the Atlantic Slope and eastern Gulf of Mexico from New Hampshire to Mississippi. With the exception of the bantam sunfish, *Lepomis symmetricus*, species of *Enneacanthus* are the smallest centrarchids (Page and Burr 1991). All three species are adapted to lowland habitats with abundant aquatic vegetation in which individuals aggregate. Their rounded caudal fins and deep, compressed bodies likely help these fishes navigate in thick aquatic vegetation. The genus *Enneacanthus* also shows extreme tolerance and adaptations to low pH in wetland habitats. Each species in the genus occurs in acid, dystrophic waters (e.g., bogs, swamps), but a gradient in tolerance exists from the most (banded sunfish) to the least tolerant (blackbanded sunfish) (Gonzalez and Dunson 1989a,b,c, 1991). Differential pH tolerance within the genus apparently exerts a strong effect on local distribution in areas of overlap (Graham and Hastings 1984; Gonzalez and Dunson 1991; Graham 1993), and in banded sunfish, it is rooted in highly specialized physiological adaptations (Gonzalez and Dunson 1989a,b,c, 1991).

Characteristics: Deep, compressed body, depth >0.4 of SL. Mouth small, jaws equal, supramaxilla small (>3 times into length of maxilla), upper jaw not extending beyond front of eye. Eye large, diameter greater than snout length. Black teardrop. Opercle with two flat extensions. Rounded, truncate, or slightly emarginate caudal fin. Dorsal fins continuous. Long dorsal fin, (7)9 to 10(11) spines, 10 to 12 rays, usually 21 total, and short anal fin, 3 spines, 9 to 13 rays, 13 to 16 total. Preopercle margin entire. Long gill rakers, 11 to 14. Ctenoid scales. Vertebrae, 28 (12 + 16). Branchiostegal rays, 6. Teeth present or absent on palatine. No teeth on entopterygoid, ectopterygoid, or glossohyal (tongue) bones (Bailey 1938; Page and Burr 1991; Mabee 1993; Jenkins and Burkhead 1994).

Similar species: See generic account for *Lepomis* and *Micropterus*.

13.7.1 Enneacanthus chaetodon *(Baird)*

13.7.1.1 Blackbanded sunfish

Characteristics: See generic account for general characteristics. Deep, compressed body, depth ≥0.55 of SL. Mouth small, terminal. Eye large, diameter >1.2 of snout length. Six bold, black bars on sides, the first passes through the eye, the third extends dorsally through anterior spiny dorsal fin and ventrally through medial portion of pelvic fin, and the sixth through the caudal peduncle (often faint). Opercular spot dark with pale medial crescent. Rounded or slightly truncate caudal fin in young and juvenile, becoming truncate or slightly emarginate in adults. Long dorsal fin, (8)10(11) spines, 11 to 12 rays, usually 21 total, and short anal fin, 3 spines, (11)12 to 13(14) rays, 14 to 16 total. Dorsal fin continuous with deep notch between spines and rays. Dorsal fin base about 1.5 times longer than anal fin base. Dorsal and caudal fins not enlarged in breeding male. Pectoral fin narrow, somewhat pointed. Lateral line complete. Lateral scales, (23)25 to 29(32); cheek scale rows, (2)3(4); caudal peduncle scale rows, (16)18 to 21(22); pectoral rays, (9)11(13). Teeth present or absent on palatine bone (Bailey 1938; Page and Burr 1991; Mabee 1993; Jenkins and Burkhead 1994).

Size and age: Typically reach 13 to 40 mm TL at age 1. Large individuals measure 40 to 60 mm TL (maximum 80 mm TL) and reach age 4+ (Schwartz 1961; Page and Burr 1991; Jenkins and Burkhead 1994). Length–weight relationships between males and females are similar in some populations (Schwartz 1961), but in a Delaware population females lived longer (age 3+) and reached larger maximum sizes (70 mm SL) than males (age 1+, <49 mm SL) (Wujtewicz 1982).

Coloration: Prominent black vertical bars on sides (see Characteristics). Dusky yellow-gray to brown or black above, light below with tiny yellow flecks on sides. Leading edges of pelvic fins red, orange, or pink; third membrane of spiny dorsal fin similarly colored. Dorsal, anal, and caudal fins with black mottling. Iris reddish orange (Page and Burr 1991; Jenkins and Burkhead 1994; Marcy *et al.* 2005).

Native range: The blackbanded sunfish is sporadically distributed below the Fall Line in Atlantic and Gulf Slope drainages from New Jersey to central Florida and west to the Flint River, Georgia. Large distributional gaps occur across the range (e.g., entire western Chesapeake basin), and populations in Georgia and Florida are isolated and widely scattered (Gilbert 1992b; Jenkins and Burkhead 1994). Four areas of concentration are evident. Three of these, the pine barrens of New Jersey, the sandhills in southeastern North Carolina, and the central highlands of Florida, are characterized by well-drained sandy soils with vegetation of pine and scrubby oak species and dystrophic, acidic waters. The fourth area is the acidic Okefenokee Swamp in Georgia (Gilbert 1992b). The broad gaps in the *E. chaetodon* distributional pattern may have arisen from prehistoric changes in sea levels, subtle ecological habitat differences, and competition with other fishes (Jenkins *et al.* 1975; T. Darden, South Carolina Department of Natural Resources, personal communication).

Habitat: The blackbanded sunfish inhabits vegetated lakes, ponds, and quiet sand- and mud-bottomed pools and backwaters of creeks and small to medium rivers (Page and Burr 1991). Distributional studies in New Jersey indicate that the species occurs most often in acidic lakes (pH range, 7.0 to 4.1) (Graham and Hastings 1984; Graham 1993) and is most frequent in streams with a pH between 5.0 and 4.5 (Zampella and Bunnell 1998). In spring samples of small, sandy North Carolina streams, the species occurred most often in active beaver ponds apparently avoiding unimpounded stream channels and abandoned beaver ponds (Snodgrass and Meffe 1998). Although certainly tolerant of acidic conditions, laboratory studies suggest it is less tolerant of low pH than congeners. At pH 4.0 and 3.5, the blackbanded sunfish experienced the greatest disturbance of net Na flux, an indicator of pH stress, among the three species of *Enneacanthus*. All individuals of the blackbanded sunfish survived and recovered from a 12-hour exposure at pH 4.0, but 60% of test animals died in <12 hours at pH 3.5 (Gonzalez and Dunson 1989a).

Food: The blackbanded sunfish apparently takes small invertebrates from the surface of vegetation, the water column, and the bottom (Reid 1950a; Schwartz 1961; Wujtewicz 1982). Aquatic insects (chironomid, caddisfly, and dragonfly larvae), amphipods, filamentous algae, and plant leaves dominate the diet; the algal and plant material are perhaps incidentally taken with invertebrates. The species apparently feeds throughout the day and perhaps even nocturnally (Schwartz 1961; Wujtewicz 1982).

Reproduction: Knowledge of the reproductive behavior and biology of the blackbanded sunfish is sketchy, limited largely to aquarium observations by hobbyists, and almost entirely based on anecdotal accounts and unpublished reports (summaries by Hardy 1978; Jenkins and Burkhead 1994). Females mature at 33 mm SL and age 1+, or perhaps age 0+; males presumably mature at age 1+ (Wujtewicz 1982). Breeding activity is associated with water temperatures of about 20 to 28°C (Breder and Rosen 1966; Wujtewicz 1982; Sternburg 1986), and spawning occurs as early as March in North Carolina (Smith 1907) and early May to late June in Delaware (Wujtewicz 1982). Adults in North Carolina streams migrate seasonally into beaver ponds to spawn, habitats which are also important for young-of-the-year (Snodgrass and Meffe 1999). The male may excavate and defend a small depressional nest (ca. 10 cm in diameter) in sand or gravel or push out hollows in filamentous algae beds or macrophytes in water about 30 cm deep (Breder 1936; Breder and Rosen 1966; Sternburg 1986). Movement of bottom materials during nest excavation has been attributed to using the mouth, body, tail, or just "finning" (Breder and Rosen 1966; Sternburg 1986; Jenkins and Burkhead 1994). Males lead the female to the nest by darting toward her, quivering, spreading the fins, and then swimming back to the nest (Breder 1936; Sternburg 1986). The pair releases gametes in the typical head-to-head, vent-to-vent centrarchid spawning position (Breder 1936; Sternburg 1986). Gamete release is repeated numerous times over about 1.5 hours with pauses of 10 to 30 seconds between bouts (Breder and Rosen 1966; Sternburg 1986). In an aquarium, two females spawned simultaneously with a single male (Sternburg 1986). Spawning in the species is apparently protracted. In aquaria, spawning occurs repeatedly over several weeks (Sternburg 1986; Rollo 1994), and in Delaware, females were gravid from early May through June (Wujtewicz 1982). Ripe eggs were 0.9 mm in diameter (Wujtewicz 1982). Eggs were small or absent in females in July in Maryland and averaged 0.3 mm in diameter in November (Schwartz 1961). Females contain 233 to 920 mature ova (33 to 52 mm SL, respectively) (Wujtewicz 1982), but all of these may not be deposited in a single spawning (Quinn 1988). Fertilized eggs are adhesive and sand colored (Hardy 1978). The male guards the eggs, which hatch in about 2 days (Breder 1936), and continues guarding the larvae until they are free swimming (about 4–5 days after hatching) (Sternburg 1986; Rollo 1994). A guardian male in an aquarium was observed picking up stray larvae in his mouth and "spitting" them back into the nest (Rollo 1994), a behavior at least unusual if not unique among centrarchids (Miller 1963). An anecdotal report of biparental care of eggs and fry also deserves further investigation (Quinn 1988).

Nest associates: None known.

Freshwater mussel host: None known.

Conservation status: The blackbanded sunfish is considered vulnerable to critically imperiled across most of its range (Warren *et al.* 2000; NatureServe 2006). The species is presumed extirpated in Pennsylvania, and only populations in New Jersey are considered secure (NatureServe 2006). The fragmented range and tendency for populations to be isolated, even though often locally common (e.g., Gilbert 1992b; Marcy *et al.* 2005), increase extirpation risk. Continuing urban, agricultural, and coastal development that involves drainage of small wetlands and ponds exacerbate the extinction risk imposed by fragmentation and isolation. Collection of specimens for aquaria may also adversely impact some low-density populations (Burkhead and Jenkins 1991).

Similar species: The banded sunfish and bluespotted sunfish lack the black pigment at the front of the dorsal fin. Small individuals of all three species are similar, but the blackbanded sunfish develops the distinctive adult markings early (about 10 mm TL) (Sternburg 1986).

Systematic notes: A southern subspecies, *E.c. elizabethae*, was described from limited samples from the Okefenokee Swamp and central Florida, based on differences in dorsal fin spine counts, caudal peduncle scale counts, and subtle aspects of pigmentation (Bailey 1941). Subsequent work suggested a north–south cline (Sweeney 1972), but larger sample sizes confirm reduced average counts in Florida and southern Georgia specimens (Gilbert 1992b).

Importance to humans: The handsome blackbanded sunfish has long been of interest to aquarists in southeast Asia, where it is cultured in large numbers and shipped back to enthusiasts in North America (Sternburg 1986; Quinn 1988; Schleser 1998) and in Germany, where it has been kept since 1897 (Jenkins and Burkhead 1994). The species is currently traded and sold on Internet websites by individuals and pet stores. Feeding, water conditioning, and breeding of the species are featured frequently in magazines and on websites of organizations promoting use of native fish in aquariums (e.g., North American Native Fish Association, The Native Fish Conservancy).

13.7.2 Enneacanthus gloriosus *(Holbrook)*

13.7.2.1 Bluespotted sunfish

Characteristics: See generic account for general characteristics. Deep, compressed body, depth 0.4 to 0.6 of SL. Mouth small, terminal, or supraterminal. Rows of blue or silver spots along sides of large young and adults; bars on sides indistinct in adults. Opercular spot dark, sometimes with pale medial crescent, usually <0.5 of eye diameter in specimens >25 mm SL. Rounded caudal fin. Long dorsal fin, (7)9(11) spines, (10)11(13) rays, usually 21 total, and short anal fin, 3 spines, (9)10(11) rays, 13 to 14 total. Dorsal fin continuous. Dorsal fin base about 1.5 to 1.7 times longer than anal fin base. Breeding male with enlarged second dorsal and anal fins; female lacks enlarged fins. Pectoral fin rounded. Lateral line may be lacking on several posterior scales. Lateral scales, (25)30 to 32(35); cheek scale rows, (3)4(5); caudal peduncle scale rows, (14)16 to 18(20); pectoral rays, (9)11 to 12(13). Teeth (cardiform) present on palatine bone (Bailey 1938; Sweeney 1972; Peterson and Ross 1987; Page and Burr 1991; Mabee 1993; Jenkins and Burkhead 1994).

Size and age: Typically reach 19 to 34 mm TL at age 1. Large individuals measure 52 to 63 mm TL (maximum 99 mm TL) and at least in northern populations reach age 5+ (Breder and Redmond 1929; Fox 1969; Werner 1972; Snyder and Peterson 1999b). In southern populations, individuals rarely live to age 4+ (Fox 1969; Snyder and Peterson 1999b). Maximal size in Gulf Coast populations is less than that in Atlantic Coast populations, a likely consequence of earlier maturity in the former (Peterson and VanderKooy 1997; Snyder and Peterson 1999b). Length to dry weight relationships did not differ for males and females in Mississippi populations (Snyder and Peterson 1999b), and older males were slightly heavier than same-age females in Florida (Fox 1969).

Coloration: Olive brown to olive or very dark midnight blue on body and head. Rows of round to oval, blue, green, silver, or gold spots along the sides of large young and adults (lacking in Mississippi populations), and extending onto head. Opercular spot black to pearly blue, often with medial blue-green crescentic mark. Spots on head and sides most developed on breeding males, which have a nearly black background with bright iridescent spots. Young and nonreproductive adults may have indistinct bars on sides. Soft dorsal, anal, and caudal fins may be pink or reddish; pale whitish spots in median fins. Iris dull red or gold (Page and Burr 1991; Jenkins and Burkhead 1994; Ross 2001; Marcy *et al.* 2005).

Native range: The bluespotted sunfish, the most wide-ranging *Enneacanthus*, occurs in the Coastal Plain and Piedmont of Atlantic and Gulf Slope drainages from southern New York south to southern Florida and westward to the Biloxi Bay drainages of southeastern Mississippi (Page and Burr 1991; Jenkins and Burkhead 1994; Ross 2001). An introduced population is established in the Black River drainage, Mississippi (Peterson and Ross 1987), and populations in the Lake Ontario drainage, New York, and Susquehanna River drainage, Pennsylvania, are of unknown provenance (Smith 1985; Fuller *et al.* 1999).

Habitat: The bluespotted sunfish inhabits vegetated lakes, ponds, and sluggish sand- and mud-bottomed pools and backwaters of creeks and small to large rivers (Fox 1969; Page and Burr 1991; Peterson and VanderKooy 1997; Snodgrass and Meffe 1998). In spring samples in North Carolina, the species occurred most often in beaver ponds rather than in unimpounded stream channels (Snodgrass and Meffe 1998). In coastal Mississippi drainages, the species almost exclusively used side ponds of oxhows, avoiding main channel habitats. In the side ponds, highest relative abundance was associated with decreased pH, decreased conductivity, and increased coverage of submergent and emergent vegetation; presence and absence of the species in the ponds was associated significantly with a mean pH of 5.6 and 6.5, respectively (Peterson and VanderKooy 1997). In New Jersey, the species was distributed independently of a color-pH gradient occurring across a pH range of about 9.0 to 4.0 (median 7.0) in lakes (Graham and Hastings 1984; Graham 1993), and in pineland streams the species occurred at a median pH between 5.0 and 4.5 (Zampella and Bunnell 1998). Growth is not affected negatively until pH declines below 4.5, but individuals survived up to 12 weeks at pH 4.0 (Gonzalez and Dunson 1989c).

Food: The bluespotted sunfish is an opportunistic diurnal forager on benthic, vegetational, and planktonic prey; adult diets are dominated by prey associated with submerged aquatic vegetation and associated sediments (Breder and Redmond 1929; Fox 1969; Graham 1989; Snyder and Peterson 1999a). Dominant adult food items are chironomid larvae (and other aquatic insects), gastropods, and small crustaceans (ostracods, copepods, cladocerans, amphipods). The young transition from a diet predominated by cladocerans, copepods, and chironomid larvae to the broader adult diet (Fox 1969; Graham 1989; Snyder and Peterson 1999a). In late summer, young-of-the-year stomachs were nearly empty at dawn, but stomach fullness and digestion of prey indicated that individuals began feeding at dawn and fed continuously until darkness (Graham 1986).

Reproduction: Maturity is reached in northern populations at age 2+ at a minimum size of about 53 mm TL (40 mm SL, Breder and Redmond 1929). Southern populations mature at age 1+ and show 50% maturity at 23 to 25 mm TL (Fox 1969; Snyder and Peterson 1999b), apparently the smallest size at maturity of any centrarchid. Spawning is protracted, and depending on latitude gravid females and small young occur from early spring through fall (Breder and Redmond 1929; Fox 1969; Wang and Kernehan 1979; Jenkins and Burkhead 1994; Snyder and Peterson 1999b; Doyle 2003). Female and male gonad to body weight ratios show initial increases as water temperatures rise above 15°C and remain high throughout much of the summer, but decline if temperatures remain above 27°C (Snyder and Peterson 1999b). Observations of nests are few and guardian male behaviors unknown, but the size, substrate, and placement of the nests are apparently similar to *E. chaetodon* (summary in Breder and Rosen 1966). Mature ova percentages increase throughout the summer, indicating continued recruitment from smaller ova classes. In Mississippi populations, there was no size–fecundity relationship (Snyder and Peterson 1999b), and the number of mature ova per female averaged 117. In Florida populations, the number of mature eggs increased from 67 to 80 in age 1+ females to an average of 400 and 500 mature eggs in age 2+ and 3+ females, respectively (Fox 1969). Mature eggs averaged 0.9 mm in diameter in freshly stripped eggs (Breder and Redmond 1929) and 0.68 mm in preserved females (Snyder and Peterson 1999b). Eggs are adhesive and demersal (Breder and Redmond 1929). Hatching occurs in 57 hours at 23°C, and length at hatching is 2.3 mm TL (Breder and Redmond 1929).

Nest associates: None known.

Freshwater mussel host: None known.

Conservation status: The bluespotted sunfish is considered currently stable over its range, but populations at the periphery of the range (Mississippi, Alabama, New York, and Maryland) are listed as vulnerable (Warren *et al*. 2000; NatureServe 2006).

Similar species: Pigmentation patterns of young bluespotted sunfish are virtually indistinguishable from banded sunfish, and even adults of the two species can be difficult to distinguish. In breeding male bluespotted sunfish the pale markings are nearly always present, are broadly oval, and are greenish yellow or gold in color; the body is often very dark, olive blue; and the dark lateral bars are absent or indistinct. In breeding male banded sunfish bright markings are sometimes present as gold-green crescentic flecks, the species never appears blue, and the lateral bars are dark and evident (Jenkins and Burkhead 1994). Average counts of caudal peduncle scale rows also appear to reliably separate the species, but traditionally used characteristics, such as completeness of the lateral line and relative size of the opercular spot, are not reliable across much of the range (Peterson and Ross 1987; Jenkins and Burkhead 1994).

Systematic notes: Evolutionary relationships among *E. gloriosus* populations and between *E. gloriosus* and *E. obesus* appear to be complex and not yet fully resolved. Phylogeographic analyses of mitochondrial DNA indicate that *E. gloriosus* and *E. obesus* are not monophyletic taxa and suggest either incomplete lineage sorting or a polyphyletic *E. obesus* (T. Darden, South Carolina Department of Natural Resources, personal communication). Introgression was detected using nuclear-encoded allozyme data in sympatric populations of the sister species pair *E. gloriosus* and *E. obesus* in New Jersey (Graham and Felley 1985). In areas of allopatry, hybridization was not detected, but appreciable introgression was present in co-occurring populations. Developmental instability was correlated positively with the degree of introgression (heterozygosity), indicating that hybridization may result in reduced fitness for the hybrid individuals (Graham and Felley 1985). Morphological variation in the two species in Virginia also shows considerable and curious overlap (Jenkins and Burkhead 1994). Phylogeographic analyses appear to support an Okefenokee Swamp–based center of dispersal for *E. gloriosus* and relatively long-term isolation and differentiation of Florida populations from other Atlantic Slope populations (T. Darden, South Carolina Department of Natural Resources, personal communication). In addition, populations in Mississippi are morphologically divergent from other *E. gloriosus* populations (Peterson and Ross 1987).

Importance to humans: The bluespotted sunfish, like its congener the blackbanded sunfish, has attracted the attention of aquarists. A perusal of Internet sites indicates that the species is regarded as an adaptable aquarium fish, although feeding and water conditioning can be challenging. The species is actively sold and traded by enthusiasts and retailers.

13.7.3 Enneacanthus obesus *(Girard)*

13.7.3.1 Banded sunfish

Characteristics: See generic account for general characteristics. Deep, compressed, somewhat thick body, depth 0.4 to 0.5 of SL. Mouth small, supraterminal, oblique. Rows of purple-gold crescentic flecks on sides; five to eight dark bars on sides. Opercular spot dark, usually >0.5 of eye diameter in specimens >25 mm SL. Rounded caudal fin. Long dorsal fin, (7)9(11) spines, (10)11(13) rays, usually 21 total, and short anal fin, 3 spines, (10)10 to 11(12), 13 to 14 total. Dorsal fin continuous. Dorsal fin base about 1.5 to 1.7 times longer than anal fin base. Breeding male with enlarged second dorsal and anal fins and longest pelvic rays distally filamentous; female lacks enlarged fins and filamentous extensions. Pectoral fin rounded. Lateral line usually interrupted or incomplete. Lateral scales, (27)30 to 32(35); cheek scale rows, (3)4(5); caudal peduncle scale rows, (17)19 to 22(24); pectoral rays, (10)11 to 12(13). Teeth (cardiform) present on palatine bone (Bailey 1938; Peterson and Ross 1987; Page and Burr 1991; Mabee 1993; Jenkins and Burkhead 1994).

Size and age: Reached 20 to 30 mm TL at age 1 in a Connecticut reservoir (Cohen 1977); age 0+ fish were 34 to 35 mm SL in October and 51 mm SL the following April in the Okefenokee Swamp (Freeman and Freeman 1985). Large individuals measure 55 mm TL (maximum 95 mm TL) and reach age 6+ (Cohen 1977; Page and Burr 1991). Males tend to live longer and grow slightly faster than females (Cohen 1977).

Coloration: Dusky olive above, light below, with olive-black or five to eight black bars on the sides that may vary in distinctiveness. Rows of purple-gold crescentic flecks along side. Opercular spot black, bordered with iridescent gold-green margin. Median fins dark with rows of blue to white spots. Breeding male, and to a lesser degree, breeding female with gold-green or blue flecks on head, body, and median fins, fin spines glowing white. Iris orange-red (Page and Burr 1991; Jenkins and Burkhead 1994). Aspects of subtle differences in coloration between *E. obesus* and *E. gloriosus* are summarized by Jenkins and Burkhead (1994).

Native range: The banded sunfish occurs primarily on the Coastal Plain of Atlantic and Gulf Slope drainages from southern New Hampshire south of central Florida and west of the Perdido River drainage of Alabama (Page and Burr 1991; Boschung and Mayden 2004). Across the range, the species can be rare to relatively common (Smith 1985; Laerm and Freeman 1986; Jenkins and Burkhead 1994; Boschung and Mayden 2004; Marcy *et al*. 2005). An introduced population is established in the Black River drainage of Mississippi (Peterson and Ross 1987).

Habitat: The banded sunfish inhabits heavily vegetated lakes, ponds, and sluggish sand- or mud-bottomed pools and backwaters of creeks and small to large rivers (Page and Burr 1991). The species is perhaps one of the most acid-tolerant fishes known (Gonzalez and Dunson 1987) and occurs in waters with pH 3.7 (e.g., New Jersey, Graham and Hastings 1984; Graham 1989; Georgia, Freeman and Freeman 1985). In multivariate studies in New Jersey, the banded sunfish was associated more strongly with acidic (pH 6.6–4.1), dystrophic habitats than either congener in lakes (Graham and Hastings 1984; Graham 1993) and in streams occurred most frequently between pH 5.0 and 4.5 (Zampella and Bunnell 1998). Individuals survived 2-week laboratory exposures to pH 3.5, and 60% of test individuals survived 3-week exposures to pH 3.3 after a gradual lowering from 3.5 over a 1-week period (Gonzalez and Dunson 1987). Growth was unaffected down to a pH of 3.75 (Gonzalez and Dunson 1989c). These findings suggest that the banded sunfish may have distinct competitive advantages over congeners and other sunfishes in low pH habitats (Gonzalez and Dunson 1991). Its tolerance of low pH is the result of complex adaptations for compensating for losses in body Na that would kill other fishes and involves the ability to limit branchial electrolyte permeability during acidic exposure (Gonzalez and Dunson 1987, 1989a,b,c). The gills of banded sunfish have a high affinity for Ca that reduces leaching by H+ and prevents high Na losses down to pH 3.5. In addition to limiting Na efflux, the species apparently can shift internal Na from osmotically inactive sources (e.g., bone) to plasma, which maintains Na concentrations of extracellular fluid. Although chronic acid exposure causes a large drop in body Na concentration (up to 52%, lethal to most fishes), these adaptations allow the banded sunfish to survive (Gonzalez and Dunson 1987, 1989a,b,c, 1991).

Food: The banded sunfish, like its sister species the bluespotted sunfish, is an opportunistic forager on benthic, vegetational, and planktonic prey; adult diets are dominated by prey associated with submerged aquatic vegetation (Chable 1947; Cohen 1977; Graham 1989). Although diets overlap substantially between the two species, the banded sunfish gleans more vegetational prey and eats less benthic and planktonic prey than the bluespotted sunfish where the two co-occur (Graham 1989). Dominant adult food items are chironomid larvae (and other aquatic insects) and small crustaceans (cladocerans, copepods, amphipods). The young transition from a diet predominated by cladocerans, copepods, and chironomid larvae to the broader adult diet (Graham 1989). In late summer, young-of-the-year stomachs were nearly empty at dawn, but stomach fullness and digestion of prey indicated that individuals began feeding at dawn, paused between late morning and midday, and then fed continuously until dark (Graham 1986).

Reproduction: Maturity is reached at age 2+ in females at a size of about 35 to 40 mm TL, but some smaller, age 1+ females are capable of spawning (Cohen 1977). Information on minimum size and age of maturity of males is lacking, but males are reproductively active by at least 59 mm TL (Harrington 1956). Gonadal development and associated nesting and spawning behaviors are controlled by increasing photoperiod and temperature (Harrington 1956). When males and females collected from ponds in fall were exposed in the laboratory to 15 hours of daylight and 21.7°C water temperature, ovary volume, ova size, testis volume, and male breeding colors developed rapidly (about 38 days), and nest building and spawning occurred. In contrast, in a parallel set of experiments at 21.7°C conducted under a fall photoperiod (9.2–11.6 hours daylight), individuals did not show gonadal enlargement or other reproduction-associated changes. In natural environments, spawning can be protracted. Gravid females and nuptial males occur from April to July in Virginia (Jenkins and Burkhead 1994), and capture of small young in Delaware suggests a late spring-through-summer breeding season (Wang and Kernehan 1979). In contrast, young-of-the-year only appeared in early June collections in a year-long sampling effort in the Okefenokee Swamp, Georgia (Freeman and Freeman 1985). Peak spawning and egg development occurred in June and July in a Connecticut reservoir at surface water temperatures of 23 to 27°C. Most details of reproductive biology, spawning behavior, and aspects of parental care are undocumented. In aquaria, breeding males establish territories, engage in threat postures and chasing, excavate depressional nests with their mouths, and vigorously defend the nest, eggs, and free-swimming larvae (Harrington 1956; Breder and Rosen 1966; Cohen 1977; Rollo 1994). One large male (52 mm SL) bred on 10 different days (of 26 days observed) and participated in 107 spawning acts under laboratory conditions (Harrington 1956). The interval between spawning acts was from 0 to 4 days. Mean fecundity, presumably based on total ova, increases with age (and size) ranging from 802 eggs at age 1 to 1400 eggs at age 6 (Cohen 1977). Mature ova are 0.6 mm in diameter. Fertilized eggs are adhesive and colorless, eggs hatch in about 3 days at 21.7°C, and larvae become free swimming about 5 days after hatching (Harrington 1956; Rollo 1994).

Nest associates: None known.

Freshwater mussel host: None known.

Conservation status: Although not in danger of imminent extinction because of occupation of broad latitudinal range across many independent drainage systems, the banded sunfish is considered vulnerable to critically imperiled in many states within its range (New Hampshire, Rhode Island, Connecticut, Virginia, Alabama, Pennsylvania, New York) (Warren *et al.* 2000; NatureServe 2006).

Similar species: See account on bluespotted sunfish.

Systematic notes: See account on *E. gloriosus*.

Importance to humans: Like congeners, the banded sunfish is popular among enthusiasts interested in keeping and rearing native fishes (Rollo 1994; Schleser 1998). Although perhaps underappreciated, the ability of the species to tolerate waters of relatively high acidity should increase scientific interest in the species.

13.8 *Lepomis* Rafinesque

The genus *Lepomis* is a monophyletic clade of 13 species and is sister to the genus *Micropterus* (Near *et al*. 2004, 2005). The natural range encompasses most of eastern North America east of the Rocky Mountains, reaching northward to the Great Lakes, St. Lawrence River, and Hudson Bay drainages of Canada and eastward and southward in the Mississippi River Basin, Atlantic Slope, and Gulf of Mexico drainages west to the Rio Grande.

Breeding males of some *Lepomis* are among the most colorful of all North American native fishes, and the reproductive habits of several species are among the best-studied and most fascinating within the fish fauna. The literature is extensive and only a brief overview is presented here and in the individual accounts. *Lepomis* share many features common to centrarchid reproduction. Males establish territories, excavate nests, fan, and guard eggs and defend newly hatched larvae until the swim-up stage. In addition, many *Lepomis* develop brilliant breeding colors and possess highly complex reproductive behaviors that can involve motor, visual, and auditory signals, and several species have evolved alternative mating strategies. Territorial breeding males excavate the typical circular depressional nest of other centrarchids, but many distinctive behaviors and combinations of behaviors are documented, often being associated with nest defense, courtship, or both. The male is faced with defending a nesting territory using agonistic behaviors and successfully mating with a female using courtship behaviors, motivations that necessarily shift from moment to moment, particularly in colonial nesters, and often appear in conflict (Keenleyside 1967; Steele and Keenleyside 1971; Ballantyne and Colgan 1978a,b,c). Males over nests display to nearby or approaching males and females using combinations of nest hovering, dashes to the surface and back to the nest, nest sweeping with the caudal fin, fin spreading, mouth gapes, jaw snaps, lateral displays (males side-by-side with fins erect), breast displays, substrate biting, and opercular spreads. Males most frequently rush toward an interloper with a quick retreat to the nest (thrust, Miller 1963), but if the intruder does not retreat, males display or actually ram, push, bite, or jaw grasp the other male. Males may also engage in rim circling, in which males repeatedly and rapidly circle their nest (e.g., over 100 circles in 30 minutes) with fins displayed (Miller 1963; Hunter 1963; Huck and Gunning 1967; Boyer and Vogele 1971; Avila 1976; Colgan *et al*. 1979; Lukas and Orth 1993). The act likely makes the male more conspicuous to females (Miller 1963; Avila 1976) but also serves as a territorial advertisement to other males (Colgan *et al*. 1979). In courtship, as a spawning-ready *Lepomis* female approaches a male's nest, the male performs courtship circles by darting from the nest with fins spread, encircling the female and leading her toward the nest (Keenleyside 1967; Boyer and Vogele 1971; Avila 1976; Ballantyne and Colgan 1978a,b,c; Gross 1982). The male may courtship circle many times in rapid succession until the female follows him to the nest or leaves (Miller 1963; Keenleyside 1967).

Augmenting the motor behaviors and breeding colors developed on the body and head, males of some species also have exaggerated opercular flaps. The ear flaps (or ear tabs) are species specific in orientation, size, and color patterns and serve as sex ornaments (secondary sexual characteristics) that play a complex role in mate choice, species recognition, and aggression between rival males (Keenleyside 1971; Colgan and Gross 1977; Stacey and Chiszar 1977). Opercle flaring directed at females is frequent in courting males (Keenleyside 1967), and the flap apparently signals to the female the species, condition, and quality of the male (Childers 1967; Goddard and Mathis 2000). Females prefer males with larger opercular flaps (e.g., *Lepomis megalotis*), and larger flaps increase the probability of a male in attaining and holding central nesting sites in a colony, where females spawn preferentially relative to peripheral nests (e.g., *Lepomis macrochirus*) (Gross and MacMillan 1981; Côté and Gross 1993; Goddard and Mathis 1997; Ehlinger 1999). Aggressiveness and dominance also are closely linked to the opercular flap. Males of at least some *Lepomis* appear to assess the resource-holding power of rivals by their opercular flap size (Goddard and Mathis 2000). Out of age, size, and seven morphological features in male bluegill, opercular flap size was the only feature that corresponded significantly with male rank in a breeding territory dominance hierarchy in experimental tanks (Ehlinger 1999).

Some territorial, breeding male *Lepomis* further augment motor and visual reproductive signals with sound. On sighting a female near his nest, a nesting male rushes toward her and back toward his nest while producing a series of gruntlike sounds (bluegill, green sunfish, longear sunfish, and redspotted sunfish) or popping sounds (pumpkinseed and redear sunfish) (Gerald 1971; Ballantyne and Colgan 1978a,b,c). The sounds are also produced as males attack other males intruding into their nesting territory or in noncourtship agonistic contexts (Ballantyne and Colgan 1978a,b,c). Sound production is attributed to manipulation of the pharyngeal jaw pads, but in agonistic or courtship contexts is not associated with feeding (Ballantyne and Colgan 1978a,b,c). Sound characteristics suggest species specificity (Gerald 1971), and conspecific and heterospecific sounds elicit auditory brainstem responses in *Lepomis* (Wysocki and Ladich 2003), but individual variation in sound characteristics is high (Ballantyne and Colgan 1978a,b,c). Females are more responsive to conspecific than heterospecific sounds, but males respond to both (Gerald 1971; Ballantyne and Colgan 1978a,b,c). Sound production may facilitate location of nesting males by females in conditions of low visibility (Gerald 1971; Steele and Keenleyside 1971), but the behavior also appears to be part of a ritualized sequence of behaviors (e.g., jaw snaps and courtship circles), signaling that the male is both highly aggressively and sexually aroused (Ballantyne and Colgan 1978a).

Alternative male reproductive strategies are highly evolved in *Lepomis* (Gross 1982; Jennings and Philipp 1992a; Philipp and Gross 1994; Avise *et al.* 2002). In a nest takeover strategy, large guardian males permanently displace small guardian males, or in nesting colonies, neighboring guardian males may intrude temporarily in another male's nest to steal fertilizations with a female (Keenleyside 1972; Avila 1976; Dominey 1981; Gross 1982; Dupuis and Keenleyside 1988; Jennings and Philipp 1992b,c; DeWoody *et al.* 1998). Nesting male *Lepomis* habituate to the appearance of males on neighboring nests and become less aggressive toward them (Colgan *et al.* 1979), so unmated neighbors can more easily intrude and steal fertilizations (Keenleyside 1972; Jennings and Philipp 1992b). These strategies, however, appear to occur in relatively low frequencies (<5% of nests, DeWoody and Avise 2001; Neff 2001).

A more common parasitic reproductive strategy is used by cuckolder males of *Lepomis*, which do not invest in parental care, but do attempt to steal fertilizations from guardian males. Small sneaker males steal fertilizations from guardian males by hovering near the nest margin and darting in and out to release sperm beneath the spawning female and guardian male (Dominey 1980; Gross 1982, 1984, 1991). When sneaker males are about as large as reproducing females, they can switch to the satellite tactic (Gross 1982). Satellite males mimic females in behavior and coloration and, if the guardian male is deceived, which occurs frequently, they can hold a position in the nest between the spawning female and guardian male and steal fertilizations (Dominey 1980; Gross 1982; Fu *et al.* 2001). Sneaker and satellite morphs are documented only in bluegill (Dominey 1980; Gross 1982). Sneaker male morphs occur in populations of longear sunfish (Jennings and Philipp 1992b,c), northern longear sunfish (Keenleyside 1972; Jennings and Philipp 1992c), pumpkinseed (Gross 1979, 1982), and spotted sunfish (DeWoody *et al.* 2000a). Cuckolder male morphs were sought but not detected in North Carolina populations of dollar sunfish, bluegill, and redbreast sunfish (Belk 1995; DeWoody *et al.* 1998; Mackiewicz *et al.* 2002). Even so, observations of the intrusion of ostensibly "small females" between spawning pairs of *Lepomis* suggest that the parasitic strategy may occur in other populations or species (e.g., Hunter 1963; Boyer and Vogele 1971; Lukas and Orth 1993).

The life history of parasitic males differs dramatically from that of guardian males. Parasitic males do not develop breeding colors and are smaller, grow slower, mature earlier, allocate more body mass to testis weight, differ in size-adjusted body shape, and are shorter lived than guardian males (Gross 1982; Jennings and Philipp 1992c; Drake *et al.* 1997; Ehlinger 1997; Ehlinger *et al.* 1997; Stoltz *et al.* 2005). Demographic analyses of bluegill populations indicate that parasitic phenotypes do not become guardian males (Dominey 1980; Gross 1982; Drake *et al.* 1997) and that alternative male phenotypes are determined early in the life history (Ehlinger *et al.* 1997). In other *Lepomis* with alternative strategies, demographic data also are suggestive, although not conclusively, of an early and permanent divergence in life history between guardian and sneaker male phenotypes (Jennings and Philipp 1992c).

Generic characteristics: Deep, compressed body (somewhat elongate in *Lepomis cyanellus* and *Lepomis gulosus*). Opercle rounded or produced into flexible ear flap. Emarginate caudal fin. Dorsal fin shallowly emarginate, spiny portion continuous with soft-rayed portion. Long dorsal fin, usually 10 spines, 10 to 12 rays, usually 20 to 21 total; and short anal fin, 3 spines, 9 to 11 rays, 12 to 14 total. Dorsal fin base about two times longer than anal fin base. Preopercle margin usually entire (weakly crenate in *L. gulosus*). Ctenoid scales. Vertebrae, 29 to 31(12 or 13 + 17 or 18). Branchiostegal rays, 6 (Bailey 1938; Page and Burr 1991; Mabee 1993; Boschung and Mayden 2004).

Similar species: Presence of three anal fin spines separates *Lepomis* from all other centrarchids except *Enneacanthus* and *Micropterus*. *Lepomis* have shallowly emarginate caudal fins (versus rounded in *Enneacanthus*) and deep, laterally compressed bodies with <55 lateral scales (versus elongate body and ≥55 lateral line scales in *Micropterus*).

13.8.1 Lepomis auritus *(Linnaeus)*

13.8.1.1 Redbreast sunfish

Characteristics: See generic account for general characteristics. Body deep, compressed, depth 0.38 to 0.48 of SL. Mouth moderate, terminal, oblique, supramaxilla small (>3 times and ≤4 times into length of maxilla), upper jaw extending to (or almost to) anterior margin of eye. Wavy blue lines apparent on preorbital area, cheek, and usually opercle. Opercular flap long, narrow, flexible, oriented horizontally or pointing upward, black to posterior margin, usually bordered above and below with blue line. Soft dorsal fin acute. Pectoral fin short and rounded, tip usually not reaching past eye when bent forward. Short thick gill rakers, 9 to 12, longest about twice the greatest width in adults. Lateral line complete. Lateral scales, (39)41 to 50(54); rows above lateral line, 7 to 9; rows below lateral line, 14 to 16(17); caudal peduncle scale rows, (21)22 to 23(25); cheek scale rows, 6 to 9; pectoral rays, (13)14(16). Pharyngeal arches narrow with short, pointed teeth. Teeth on palatine bone. No teeth on endopterygoid, ectopterygoid, or glossohyal (tongue) bones (Scott and Crossman 1973; Barlow 1980; Etnier and Starnes 1993; Mabee 1993; Boschung and Mayden 2004).

Size and age: Size at age 1 is highly variable among habitat types and latitudes, ranging from 32 to 102 mm TL (median 59 mm). Large individuals measure 200 to 250 mm TL, weigh 150 to 300 g, and attain age 5+ to 7+ (maximum 305 mm TL, age 8+) (Bass and Hitt 1974; Sandow *et al.* 1975; Carlander 1977; Page and Burr 1991; Marcy *et al.* 2005). World angling record, 0.79 kg, Florida (IGFA 2006). Florida angling record, 0.94 kg (FFWCC 2006). Growth differences between males and females are minimal to nonexistent (Sandow *et al.* 1975; Carlander 1977).

Coloration: Narrow, elongate black ear flap, dark to posterior margin, bordered above and below with blue lines. Wavy, often narrow, blue lines radiate from mouth across sides of snout onto cheek and opercle, broken and often less distinct on opercle. Dark olive above and on sides with yellow flecks and rows of red-brown to orange spots on upper sides, orange spots scattered on lower side. White to orange below. Clear to dusky yellow to orange fins. Breeding male with bright orange breast and belly, orange fins, light powder blue sides with orange spots (Page and Burr 1991; Jenkins and Burkhead 1994; Marcy *et al.* 2005).

Native range: The redbreast sunfish is native to the Atlantic and Gulf Slopes from New Brunswick to central Florida and west to the Apalachicola and possibly the Choctawhatchee River drainages of Georgia and Florida. The native or introduced status in the Tallapoosa and upper Coosa rivers of Alabama and Georgia, where the species is widespread and common, is uncertain (Boschung and Mayden 2004). The species has been widely introduced and is established well outside its native range (e.g., Rio Grande to southeastern Ohio River basin) and in some areas (e.g., upper Tennessee River drainage) may be displacing native *Lepomis* (Page and Burr 1991; Etnier and Starnes 1993; Fuller *et al.* 1999; Miller 2005).

Habitat: The redbreast sunfish inhabits rocky, sandy, or mud-bottomed pools of creeks and small to medium rivers and can also occur in lakes, ponds, or reservoirs (Page and Burr 1991). The species is usually associated with cover (e.g., instream wood, stumps, or undercut banks), and in streams, abundance increases with decreasing water velocity and increasing depth and cover (Meffe and Sheldon 1988). Redbreast sunfish are relatively sedentary (home activity area usually <100 m stream length), but long-distance movements (1–17 km) occur (Hall 1972; Gatz and Adams 1994; Freeman 1995). Peak movements occur in the spring before spawning (Hall 1972; Hudson and Hester 1975; Gatz and Adams 1994).

Food: The redbreast sunfish is an opportunistic invertivore that may feed most heavily during the day or at night (Cooner and Bayne 1982; Bowles and Short 1988; Johnson and Dropkin 1993). Aquatic insects, particularly mayfly, dragonfly, caddisfly, and dipteran larvae, make up the bulk of the diet. Gastropods, aquatic beetles, terrestrial and emerging aquatic insects, crustaceans, and a wide variety of other invertebrate taxa also are consumed frequently, but fish, although eaten, are not important dietary items. As young redbreast sunfish grow, the diet increasingly includes larger aquatic invertebrates and more aerial and terrestrial insects (Sandow *et al.* 1975; Cooner and Bayne 1982; Sheldon and Meffe 1993; Murphy *et al.* 2005). High volumes of vegetation and organic debris in stomachs suggest concentrated foraging among plants and on the bottom (Davis 1972; Bass and Hitt 1974; Sandow *et al.* 1975; Cooner and Bayne 1982). In the summer, diversity of food items in the diet was highest in daylight hours, but feeding occurred throughout a 24-hour period (Cooner and Bayne 1982), and in the fall, feeding peaked between 2000 and 0400 hours (Johnson and Dropkin 1993). In late winter, indirect evidence indicates elective feeding on nocturnally drifting amphipods (Bowles and Short 1988).

Reproduction: Maturity is reached at ages 1+ to 2+ at a minimum size of about 90 to 114 mm TL (Davis 1972; Bass and Hitt 1974; Sandow *et al.* 1975; Lukas and Orth 1993). Nest building and spawning begin as water temperature increases from about 17 to 20°C and continues to 31°C. Spawning is protracted (April–early June to August or even October), depending in part on latitude (Bass and Hitt 1974; Lukas and Orth 1993). Nesting activity decreases over the summer and is related strongly to the number of degree days accumulated after water temperatures reach 20°C, although declines may also be related to renesting by unsuccessful males or declining numbers of spawning-ready females (Sandow *et al.* 1975; Lukas and Orth 1993). Males excavate depressional nests by carrying stones in their mouth and by caudal sweeping. Nests are 47 to 94 cm in diameter, 4 to 15 cm deep, and at water depths of 36 to 200 cm. Nests are usually placed in low-velocity habitats over coarse sand, gravel, or sand–gravel substrates and near cover of logs, stumps, boulders, plants, or bedrock ledges (Breder 1936; Miller 1963; Davis 1972; Sandow *et al.* 1975; Thorp *et al.* 1989; Helfrich *et al.* 1991; Lukas and Orth 1993; Marcy *et al.* 2005). Active nests may be widely spaced (4.5–9.1 m apart) or occur in loose aggregations of >80 nests (about 1.9 m apart) (Lukas and Orth 1993; Fletcher 1993). Nesting and spawning occurs in tidal waters supporting marine faunal elements, beaver ponds, backwaters, coves, and main flowing channels (Davis 1972; Bass and Hitt 1974; Sandow *et al.* 1975; Thorp *et al.* 1989; Helfrich *et al.* 1991; Lukas and Orth 1993; Snodgrass and Meffe 1999; Marcy *et al.* 2005). Nesting males (114–174 mm TL) may actively court females or females may enter nests with no courtship, ultimately spawning with two to six or more nest-guarding males (Lukas and Orth 1993; DeWoody *et al.* 1998). Reported spawning behaviors appear typical of most *Lepomis* (e.g., nest circling, repeated dips), but males use caudal sweeping to mix fertilized eggs into the nest substrate (Miller 1963; Lukas and Orth 1993). Genetic paternity analyses in a North Carolina population indicated that nest-guarding males sired most (>96%) of the young in their nests. Nest takeovers were rare, but 44% of assayed nests contained low percentages of offspring from nonguardian males, even though no sneaker male morphs were detected (DeWoody *et al.* 1998; DeWoody and Avise 2001). Intrusion by an ostensible female between a spawning pair (Lukas and Orth 1993) also suggests the possibility of sneaker males in some populations. Mature ovarian eggs range from 0.90 to 1.64 mm (mean 1.20 mm) (Sandow *et al.* 1975). The relationship between total number of mature ova (Y) and total length (X) is described by the linear function $\log Y = -3.8786 + 3.1628 \log X$ ($n = 79$, $R^2 = 0.71$, equation from Sandow *et al.* 1975). At a median size of 153 mm TL, a female can potentially produce 1074 mature eggs in a single batch (range: 435 at 115 mm TL to 6104 eggs at 265 mm TL). The adhesive, yellow to amber, fertilized eggs hatch in 3 days at 20 to 24°C. Newly hatched larvae are 4.6 to 5.1 mm TL, and most larvae are free swimming at 7.6 to 8.2 mm TL (Hardy 1978; Buynak and Mohr 1978; Yeager 1981). The guardian male vigorously defends the nest, eggs, and larvae from nest predators, may reduce foraging activity, and may cannibalize offspring in his own nest (Thorp *et al.* 1989; Lukas and Orth 1993; DeWoody *et al.* 2001).

Nest associates: Dusky shiner, *Notropis cummingsae* (Fletcher 1993); swallowtail shiner, *Notropis procne* (Buynak and Mohr 1978); golden shiner, *Notemigonus crysoleucas* (Shao 1997).

Freshwater mussel host: Putative host to *Lampsilis teres*, *L. recta*, and *V. constricta* (unpublished sources in OSUDM 2006).

Conservation status: The redbreast sunfish is widespread and often abundant within its native range. It is considered vulnerable in Rhode Island, Massachusetts, and New York (Smith 1985; NatureServe 2006). In Massachusetts, it appears to have declined since the mid-1800s owing to changes in water quality or behavioral interactions with introduced species, especially the bluegill (Hartel *et al.* 2002).

Similar species: Adult longear, northern longear, and dollar sunfishes have a shorter ear flap that is bordered by a white or orange edge, possess blue marbling or spots on the side of the adult, and lack distinct rows of red-brown spots on the upper side (Page and Burr 1991).

Systematic notes: *Lepomis auritus* is sister to a clade inclusive of *L. marginatus*, *L. megalotis*, and *L. peltastes* (Near *et al.* 2004, 2005). Comparative studies of variation across the range of *L. auritus* are lacking.

Importance to humans: The redbreast sunfish is a popular, sought-after sport fish in streams and rivers across most of the Atlantic Slope and eastern Gulf Coast (e.g., Suwannee River). On light tackle, redbreast sunfish offer excellent sport, being somewhat more aggressive, more surface oriented, and more active in cool waters than bluegill. The quality of the flesh is excellent and rated higher than that of *Micropterus* by some (Etnier and Starnes 1993; Jenkins and Burkhead 1994).

13.8.2 Lepomis cyanellus *Rafinesque*

13.8.2.1 Green sunfish

Characteristics: See generic account for general characteristics. Body deep, compressed, but elongate and thick relative to other *Lepomis*, depth 0.37 to 0.45 of SL. Mouth large, terminal, slightly oblique, supramaxilla small (>3 and ≤4 times length of maxilla), upper jaw extends well beyond anterior edge of eye, and in large individuals may extend to posterior edge of eye or beyond. Adult with dark spot at posterior base of soft dorsal and sometimes anal fin. Green to blue wavy lines on sides of snout, cheek, and opercle. Opercular flap stiff, short, black in center, edged in pale or yellow tinge that extends forward to form light borders above and below. Pectoral fin short and rounded, tip usually not reaching eye when laid forward across cheek. Long slender gill rakers, 11 to 14, longest about six times greatest width, thicker in large adults. Lateral line complete. Scales small. Lateral scales, (41)45 to 50(53); rows above lateral line, 8 to 10; rows below lateral line, 16 to 19; cheek scale rows, 6 to 9; caudal peduncle scale rows, 23 to 25; pectoral rays, 13 to 15. Pharyngeal arches narrow, strong, with small, thin, sharply pointed to conically blunt teeth. Teeth on palatine bone. No teeth on endopterygoid, ectopterygoid, or glossohyal (tongue, rarely a few teeth present) bones (Bailey 1938; Childers 1967; Trautman 1981; Becker 1983; Page and Burr 1991; Etnier and Starnes 1993; Mabee 1993).

Size and age: Size at age 1 is highly variable among habitats and across latitudes, ranging from 30 to 165 mm TL (median 51 mm). Large individuals measure 150 to 225 mm TL, weigh 85 to 200 g, and attain age 5+ to 6+ (maximum 310 mm TL, age 10+) (Carlander 1977; Page and Burr 1991; Pflieger 1997; Quist and Guy 2001). World angling record, 0.96 kg, Missouri (IGFA 2006). Growth in mid-western prairie streams, where the species is common, is associated positively with abundance of instream wood, likely reflecting cover or food resources associated with wood (Quist and Guy 2001). Males may grow faster and perhaps live longer than females, but differences can be slight, becoming most apparent in individuals >100 mm TL (Hubbs and Cooper 1935; Carlander 1977).

Coloration: Black, relatively short, ear flap with conspicuous light border. Wavy, often narrow, blue lines radiate from mouth across sides of snout onto cheek and opercle (often broken on opercle). Yellow, orange, or whitish margins on second dorsal fin, caudal fin lobes, anal fin, and pelvic fins, more prominent in breeding males. Blue-green above and on sides; iridescent, narrow, pale blue stripes on body scales interspersed with yellow metallic flecking; the blue stripes often broken into irregular mottling or spotting, especially posteriorly; sometimes with dusky bars on side. White to yellow belly (Hunter 1963; Page and Burr 1991; Etnier and Starnes 1993; Jenkins and Burkhead 1994).

Native range: The green sunfish is native to the east-central United States, west of the Appalachians from the Great Lakes, Hudson Bay, and Mississippi River Basins from New York and Ontario to Minnesota and South Dakota and south to the Gulf Slope drainages from the Escambia River, Florida, and Mobile Basin, Georgia and Alabama, west to the lower Rio Grande basin, Texas, and northern Mexico (Page and Burr 1991; Miller 2005). The species has been widely introduced and is established over much of the United States including Atlantic and Pacific Slope drainages and Hawaii (Page and Burr 1991; Fuller *et al*. 1999). Introduced populations of green sunfish in Atlantic Slope and in western US waters are implicated in suppression and decline of native game and nongame fishes as well as frogs and salamanders (Lemly 1985; Fuller *et al*. 1999; Dudley and Matter 2000; Moyle 2002).

Habitat: The green sunfish is a highly successful, aggressive, competitive species occurring in a variety of habitats including clear to turbid headwaters, sluggish pools of large streams, isolated, dry season–stream pools, and shallow shorelines of lakes, ponds, and reservoirs (Werner and Hall 1977; Werner *et al*. 1977; Capone and Kushlan 1991; Page and Burr 1991; Etnier and Starnes 1993; Taylor and Warren 2001; Smiley *et al*. 2005). In pond experiments, the presence of green sunfish induced dramatic shifts in foraging habitat and prey types in co-occurring congeners (Werner and Hall 1977, 1979). Green sunfish also invoke strong antipredator behaviors in aquatic insects and amphibians (e.g., Sih *et al*. 1992; Krupa and Sih 1998). The species is among the most tolerant of *Lepomis* to adverse conditions of high turbidity (<3500 FTU), low dissolved oxygen (DO) (<1 ppm), high temperatures (average critical thermal maxima 37.9°C, acclimated at 26°C), and high alkalinity (>2000 ppm, pH = 9.5) (McCarraher 1971; Horkel and Pearson 1976; Matthews 1987; Smale and Rabeni 1995a,b; Beitinger *et al*. 2000). Marked individuals in streams may show little movement, being recaptured in home pools over multiple seasons or longer (Gerking 1950, 1953; Smithson and Johnston 1999). Homing ability after short-distance displacement, exploratory pool-to-pool movements (>400 m), and long-distance movements (>16 km) are documented (Funk 1957; Hasler and Wisby 1958; Kudrna 1965; Smithson and Johnston 1999). The green sunfish is also an adept disperser and "pioneer" species, rapidly colonizing streams recovering from seasonal drying or drought, moving into and out of seasonally inundated floodplain habitats, and often invading ponds or small lakes (Ross and Baker 1983; Matthews 1987; Kwak 1988; Capone and Kushlan 1991; Etnier and Starnes 1993; Taylor and Warren 2001; Moyle 2002; Adams and Warren 2005).

Food: The adult green sunfish is a solitary ambush predator whose large mouth allows it to feed on larger food items at a given body size than most congeners (Sadzikowski and Wallace 1976; Werner and Hall 1977). The size-adjusted gape area of the species is the second largest within the genus (see *L. gulosus*; Collar *et al.* 2005a,b). The adult diet consists primarily of aquatic insects, particularly large odonate, mayfly, and beetle larvae; fish; crayfish; and terrestrial invertebrates, but a variety of other taxa are consumed (e.g., snails, and unusually, a bat) (Minckley 1963; Applegate *et al.* 1967; Etnier 1971; Sadzikowski and Wallace 1976; Werner 1977; Carlander 1977; Lemly 1985). Young green sunfish transition from an initial diet of microcrustaceans to larger invertebrates and at 50 to 99 mm TL increase consumption of crayfishes and fishes (Applegate *et al.* 1967; Mittelbach and Persson 1998). High volumes of plant material in stomachs are indicative of considerable foraging for invertebrates, such as odonate larvae, associated with vegetation (Etnier 1971; Sadzikowski and Wallace 1976). In laboratory studies, activity levels are largely diurnal, peaking at dusk and dawn, but the presence in stomachs of prey only available after dark indicates a nocturnal or at least crepuscular component to feeding (Etnier 1971; Beitinger *et al.* 1975; Langley *et al.* 1993). Green sunfish produce a chemical alarm substance that induces antipredatory behaviors in conspecifics, regardless of size. In contrast, chemical alarm cues from sympatric heterospecific fishes induce antipredator responses in juvenile green sunfish and foraging responses in adults (Golub and Brown 2003).

Reproduction: Maturity is reached at age 1+ to 3+ at a minimum size of about 45 to 76 mm TL (Carlander 1977). The combined effects of increased photoperiod (15 hours) and rising temperature in spring control prespawning gonadal development (Kaya and Hasler 1972; Smith 1975). Under controlled photoperiods, temperature, and food availability, 6-month old individuals (60–100 mm TL) can be induced to spawn (Smith 1975). Spawning is protracted (mid-May to early August), with the initiation of spawning depending in part on latitude (Hunter 1963; Kaya and Hasler 1972; Carlander 1977; Pflieger 1997). Nest building and spawning begin as water temperatures increase to 20°C, and peak spawning occurs between about 20 and 28°C (Hunter 1963). Nesting activity decreases and gonadal regression occurs as water temperatures remain over 28°C for extended periods (Hunter 1963; Kaya 1973). Males excavate nests by caudal sweeping. Nests are about 31 cm in diameter and usually placed over gravel in open, shallow areas (4–35 cm water depth, rarely 100 cm). Within a population, small males nest later in the season and in shallower water than large males (Hunter 1963), and at similar latitudes, individuals from stunted populations become ripe 2 to 4 weeks later than nonstunted populations (Childers 1967). Nests may be widely spaced (up to 30 m apart) when population densities are low but can also be placed rim-to-rim in crowded colonies (Hunter 1963; Childers 1967; Pflieger 1997). Colony formation closely parallels that of other colonial-nesting *Lepomis* (e.g., Bietz 1981; Neff *et al.* 2004), but whether colonial nesting occurs in the absence of habitat limitation is not completely clear (Hunter 1963; Childers 1967; Pflieger 1997). Spawning events are synchronous in colonies, occurring at intervals of 8 to 9 days over the spawning season; males may nest five or more times in succession during this period, and females presumably participate in multiple spawning events (three to six) over the season (Hunter 1963). Nest-guarding males produce gruntlike sounds as part of courtship (Gerald 1971); other reported courtship, spawning, and nest defense behaviors appear typical for the genus (Hunter 1963; Childers 1967). During nest building and spawning, males are territorial, aggressive, and even combative toward other males, females, and nest predators; only the most persistent spawning-ready females are allowed into the nest. Activity of spawning males is intensified. For example, in a 10-minute period a guardian male completed five spawning acts, made ten defensive forays outside the nest, threatened his neighbor once, and rim-circled 39 times (Hunter 1963). During a given spawning event, females attempt to mate (and likely do mate) with multiple males, but appear most attracted to males that are already spawning. Occasional intrusions by an ostensible female between a spawning pair (Hunter 1963) suggest the presence of sneaker males in at least some populations, but alternative mating systems in green sunfish are unconfirmed. Mature ovarian eggs are 0.8 to 1.0 mm in diameter, and fertilized eggs are 1.0 to 1.4 mm in diameter (mean 1.23 mm) (Meyer 1970; Kaya and Hasler 1972; Taubert 1977). Depending on their size, females may carry 2000 to 10,000 eggs (Beckman 1952 in Moyle 2002), but little else is apparently known about fecundity. The adhesive, fertilized eggs hatch in 2.1 days at 23.8°C (1.3 days at 27.1°C) (Childers 1967). Newly hatched larvae are 3.6 to 3.7 mm TL, and, depending on temperature, larvae are free swimming for ahout 3 to 6 days after fertilization at 4.6 to 6.3 mm TL (Childers 1967; Meyer 1970; Taubert

1977). Successful males guard and vigorously defend the nest, eggs, and larvae for 5 to 7 days, but earlier abandonment of nests is common (Hunter 1963).

Nest associates: Red shiner, *Cyprinella lutrensis* (Pflieger 1997); redfin shiner, *Lythrurus umbratilis* (Hunter and Wisby 1961; Hunter and Hasler 1965; Snelson and Pflieger 1975; Trautman 1981; Johnston 1994a,b; Pflieger 1997); golden shiner, *N. crysoleucas* (suspected, Pflieger 1997); Topeka shiner, *Natropis topeka* (Pflieger 1997).

Freshwater mussel host: Confirmed host to *A. ligamentina, Anodonta suborbiculata, Elliptio complanata, Glebula rotundata, Lampsilis altilis, Lampsilis bracteata, Lampsilis cardium, Lampsilis higginsii, Lampsilis hydiana, L. reeveiana, Lasmigona complanata, Ligumia subrostrata, L. recta, Megalonaias nervosa, P. grandis, V. iris, Villosa vibex*, and *U. imbecillis* (Young 1911; Lefevre and Curtis 1912; Tucker 1927, 1928; Stern and Felder 1978; Trdan and Hoeh 1982; Parker *et al.* 1984; Waller and Holland-Bartels 1988; Howells 1997; Barnhart and Roberts 1997; Haag *et al.* 1999; O'Dee and Watters 2000). Putative host to *A. plicata, Lampsilis radiata, Lasmigona compressa, S. undulatus, Toxolasma lividus*, and *Toxolasma parvus*, (unpublished sources in OSUDM 2006).

Conservation status: Although abundant in few natural habitats (e.g., Pflieger 1997; Quist and Guy 2001), the green sunfish is widespread and stable within its native range.

Similar species: Other *Lepomis* lack yellow-orange edges on the fins and the black spot at posterior base of the dorsal fin (except the bluegill) and have a smaller mouth (except the warmouth). The bluegill has long, pointed pectoral fins, and the warmouth has dark red-brown lines radiating posteriorly from the eye, mottling on the side, and a small patch of teeth on the tongue (Page and Burr 1991).

Systematic notes: *Lepomis cyanellus* forms a sister pair with *L. symmetricus*, and the pair represents the second largest and the smallest *Lepomis*, respectively (Near *et al.* 2004, 2005). Comparative studies of variation across the range of *L. cyanellus* are lacking.

Importance to humans: The green sunfish rarely reaches a size of interest to anglers other than children. Because of its propensity to invade, overpopulate, stunt, and compete with other fishes in ponds or small lakes, green sunfish are considered a pest by those attempting to maintain quality bluegill-bass sport fisheries. The species is commonly used by anglers as live bait on trotlines, set hooks, and jugs for catfishes. Hybrids between a female green sunfish and a male bluegill (known as "hybrid bream") are cultured and stocked in ponds to create put-and-take fisheries. The hybrids are aggressive, fast growing, and easy to catch, and if properly managed, produce excellent results (Ross 2001).

13.8.3 Lepomis gibbosus *(Linnaeus)*

13.8.3.1 Pumpkinseed

Characteristics: See generic account for general characteristics. Body, deep, compressed, often almost disk-like, depth about 0.40 to 0.53 of SL. Mouth moderate, terminal, slightly oblique, supramaxilla absent, upper jaw extends almost to, or to, anterior edge of eye. Wavy blue lines on cheek and opercle of adult. Bold dark brown wavy lines or orange spots on soft dorsal, anal, and caudal fins. Opercular flap stiff, short, with black center bordered in white or yellow with a prominent red (males) to yellowish (females) semicircular spot at posterior edge (often pale or yellowish in young). Pectoral fin long, sharply pointed, usually reaching far past eye when laid forward across cheek. Short, thick gill rakers, about 12; scarcely longer than wide. Lateral line complete. Lateral scales, (35)37 to 44(47); rows above lateral line, 6 to 8; rows below lateral line, 12 to 15; cheek scale rows, 3 to 6; caudal peduncle scale rows, 17 to 21; pectoral rays, 11 to 14. Pharyngeal arches extremely broad, heavy with large rounded, molariform teeth. Teeth present or absent on palatine bone. No teeth on endopterygoid, ectopterygoid, or glossohyal (tongue) bones (Scott and Crossman 1973; Trautman 1981; Becker 1983; Page and Burr 1991; Mabee 1993; Jenkins and Burkhead 1994).

Size and age: Size at age 1 is highly variable among habitats and across latitudes, ranging from 15 to 99 mm TL (median 40 mm). Large individuals measure 150 to 225 mm TL, weigh about 150 to 200 g, and attain age 6 to 9+ (maximum 400 mm TL, age 10+) (Carlander 1977; Page and Burr 1991; Fox 1994). World angling record, 0.63 kg, New Mexico (IGFA

2006). Pumpkinseed populations sympatric with bluegill show increased early growth rates, despite reduced resources, relative to populations allopatric with bluegill, providing evidence for counter-gradient evolutionary selection for rapid growth (Arendt and Wilson 1997, 1999). Older males tend to be larger than same-age females, and subtle differences in body form occur between male and female pumpkinseed (Deacon and Keast 1987; Brinsmead and Fox 2002).

Coloration: Ear flap black with light border, marked with bright red or yellow-orange spot on posterior edge. Wavy, usually wide, blue lines radiate from mouth across sides of snout onto cheek and opercle of adult. Many bold dark brown wavy lines or orange spots on second dorsal, caudal, and anal fins. Olive above and on sides with many gold and yellow flecks. Adults blue-green, spotted with orange; dusky chainlike bars mark sides of young and adult female; white to red-orange below (Page and Burr 1991).

Native range: The pumpkinseed is native to Atlantic Slope drainages from New Brunswick south to the Edisto River, South Carolina, and to the Great Lakes, Hudson Bay, and upper Mississippi River Basins from Quebec and New York west to southeast Manitoba and North Dakota and south to northern Kentucky and Missouri. The species has been widely introduced and is established over much of the United States and southern Canada, including some Pacific Slope drainages (Scott and Crossman 1973; Page and Burr 1991; Fuller *et al.* 1999; Moyle 2002).

Habitat: The pumpkinseed inhabits vegetated lakes and ponds and quiet vegetated pools of creeks and small rivers (Page and Burr 1991). Lake- and stream-dwelling populations differ in subtle aspects of body morphology (e.g., pectoral fin length), differences attributed to adaptation to lentic versus lotic environments (Brinsmead and Fox 2002). Juvenile and adult pumpkinseed tend toward lengthy occupancy of home activity areas (about $11\,m^2$ to 1.12 hectares, respectively) and can home to those areas when displaced (Shoemaker 1952; Hasler *et al.* 1958; Kudrna 1965; Reed 1971; Fish and Savitz 1983; Wilson *et al.* 1993; Coleman and Wilson 1996; McCairns and Fox 2004).

Food: The pumpkinseed is a highly specialized molluscivore, feeding primarily on snails by crushing them between heavy pharyngeal jaw bones that are equipped with molariform teeth, enlarged muscles, and specialized neuromuscular adaptations (Lauder 1983a,b, 1986; Hambright and Hall 1992; Wainwright and Lauder 1992; Huckins 1997). Adults also feed heavily on dipteran, mayfly, and caddisfly larvae and beetles, and also ingest cladocerans, amphipods, isopods, ostracods, larval odonates, and terrestrial invertebrates (Seaburg and Moyle 1964; Sadzikowski and Wallace 1976; Keast 1978; Laughlin and Werner 1980; Deacon and Keast 1987; Huckins 1997; Jastrebski and Robinson 2004). Young age-0 fish (>18 mm TL) consume a diet predominated in biomass by zooplankton and chironomids (Hanson and Qadri 1984), and at least in pond experiments, their combined predatory effects can change zooplankton composition (Hambright and Hall 1992). As they grow from 35 to 100 mm TL, the young transition gradually from a diet of soft-bodied littoral invertebrates to high numbers of snails (Keast 1978; Mittelbach 1984a; Keast and Fox 1990; Osenberg *et al.* 1992; Huckins 1997). Full development of the pharyngeal snail-crushing apparatus of pumpkinseeds depends on repeated, consistent consumption of snails (Bailey 1938). Pharyngeal bones and musculature associated with snail crushing are substantially reduced in individuals in snail-poor lakes relative to individuals from snail-rich lakes (Wainwright *et al.* 1991; Mittelbach *et al.* 1992; Osenberg *et al.* 2004). In the summer, peaks in feeding occur in late afternoon and at dawn with reduced but notable feeding after midnight (Keast and Welsh 1968). In the fall, daylight feeding is low and feeding peaks occur between 2000 and 0400 hours (Johnson and Dropkin 1993). In summer, age-0 pumpkinseed feed from shortly after sunrise until sunset (Hanson and Qadri 1984). Periodic infrared videography of foraging pumpkinseed over 8 months revealed frequent nocturnal foraging, mediated by a switch from benthic picking during daylight to zooplanktivory at night (Collins and Hinch 1993). In support of these field observations, laboratory experiments indicate volumes searched and feeding rates on zooplankton decrease at light intensities $\leq$10 lux (Hartleb and Haney 1998). Pumpkinseeds produce a chemical alarm substance that induces antipredatory behaviors in conspecific juveniles (<45 mm SL), but depending on the concentration, elicits either antipredatory or foraging responses in conspecific adults (>95 mm SL) (Marcus and Brown 2003; Golub *et al.* 2005). Response of juveniles to alarm cues was diminished under weakly acidic conditions (pH 6.0) (LeDuc *et al.* 2003). Pumpkinseed also respond to chemical alarm cues of largemouth bass (and ostariophysan alarm chemicals), but the response is mediated by size and habitat complexity. Under conditions of low to intermediate habitat complexity, large pumpkinseed (>80 mm SL) exhibit foraging responses and small pumpkinseed antipredator responses to bass chemical alarm cues. In highly complex habitat, both large and small pumpkinseed show antipredator responses to bass chemical alarm cues (Golub *et al.* 2005).

Lake-dwelling pumpkinseeds show subtle intra- or interpopulation differences in body form (e.g., body depth, fin length, gill raker spacing) that are strongly associated with specializations for pelagic or littoral feeding (Robinson *et al.* 1996; Robinson and Schluter 2000; Brinsmead and Fox 2002; Gillespie and Fox 2003; Jastrebski and Robinson 2004; McCairns and Fox 2004). Intermediate forms occur in both habitats but show reduced fitness in growth and body condition (Robinson *et al.* 1996). Evidence from parasite analyses and strong site fidelity in pelagic and littoral zone pumpkinseed morphs suggest that trophic divergence and habitat segregation come into play early in the life history and could potentially affect gene flow (Robinson *et al.* 2000; Jastrebski and Robinson 2004; McCairns and Fox 2004). Intrapopulation morphological divergence between trophic morphs occurs across a relatively broad geographic region (Robinson *et al.* 2000; Gillespie and Fox 2003; Jastrebski and Robinson 2004). Divergence is expressed in the absence of open-water competitors (i.e. bluegill or other *Lepomis*) (Robinson *et al.* 1993), but may also be mediated by complex interactions of a number of ecological factors (Robinson *et al.* 2000).

Reproduction: Maturity is reached at age 1+ to 4+ at 65 to 130 mm TL. Within a population, females may mature earlier and at smaller sizes than males (Carlander 1977; Fox and Keast 1991; Fox 1994; Danylchuk and Fox 1994; Fox *et al.* 1997). Age and size at maturity, onset and duration of spawning, size of eggs, and energy allocated for reproduction are plastic, varying in different, but proximate habitats (e.g., beaver ponds and nearby lakes, adjacent lakes) or regionally. Trade-offs among somatic growth and reproductive timing and allocation are linked to energy limitations, resource uncertainty in highly variable environments, and presence of other *Lepomis* (Deacon and Keast 1987; Fox and Keast 1991; Danylchuk and Fox 1994; Fox 1994; Fox *et al.* 1997). Spawning is protracted (early May to August), the initiation of spawning depending in part on latitude and population size structure (Burns 1976; Carlander 1977; Danylchuk and Fox 1994; Fox and Crivelli 1998). Gonadal development in both sexes accelerates as water temperatures warm to 12.0°C and photoperiod lengthens to 13.5 hours (Burns 1976). A combination of long photoperiod (16 hours) and warm temperature (25°C) induces nest-building behaviors in males (Smith 1970). Nest building and spawning begin as water temperatures increase to 17°C, and peak spawning occurs between about 20 and 22°C, but continues to at least 26°C (Miller 1963; Fox and Crivelli 1998; Cooke *et al.* 2006). Onset of spawning is later and the spawning season is longer in stunted than in nonstunted populations (Danylchuk and Fox 1994). Males excavate nests by caudal sweeping and uprooting and carrying away plants; conspecific or other centrarchid nests are often appropriated or reused (Ingram and Odum 1941; Miller 1963). Nests are 30 to 80 cm in diameter, at water depths of 18 to 50 cm (rarely >1 m), and often near simple cover (e.g., log, stump, boulder). Sand or small rocky substrates are chosen most often for nest sites, but a variety of substrates are used (Breder 1936; Ingram and Odum 1941; Colgan and Ealey 1973; Popiel *et al.* 1996). Nests are usually solitary (>1 m apart), but groups of two or three nests may be rim to rim (Ingram and Odum 1941; Miller 1963; Clark and Keenleyside 1967; Colgan and Ealey 1973). Nest-guarding males produce popping sounds as part of courtship of females and aggression toward conspecific males and other *Lepomis* (Gerald 1971; Ballantyne and Colgan 1978a,b,c). Other reported courtship, spawning, and nest defense behaviors appear typical for the genus (e.g., aggressive displays, courtship circles, rim circling) (Miller 1963; Steele and Keenleyside 1971; Colgan and Gross 1977; Colgan *et al.* 1981; Becker 1983; Clarke *et al.* 1984). Sneaker males are documented for pumpkinseed (Gross 1979), but in one surveyed population, guardian males sired about 85% of the larvae in their nests (range, 43–100%) (Rios-Cardenas and Webster 2005). Mature ovarian eggs average 1.11 mm diameter (Gross and Sargent 1985), but 0.6 to 1.0 mm and 0.8 to 1.2 mm diameters are ranges reported for fertilized or fertilized and water-hardened eggs, respectively (Hardy 1978; Cooke *et al.* 2006). Female batch fecundity increases with weight, but varies significantly among populations (Deacon and Keast 1987). The relationship between batch fecundity (Y) and total weight (X) is described by the linear function, $\log_{10} Y = -0.0592 + 1.9461 \log_{10} X$ ($n = 37$, $R^2 = 0.20$, one of four equations from Deacon and Keast 1987). At 48 g (128 mm TL), a female can potentially produce 5455 mature eggs in a single batch (range: 2451 at 20 g and 98 mm TL to 10,633 eggs at 126 g and 184 mm SL, respectively). The white to transparent, adhesive, fertilized eggs hatch in about 3 days at 18 to 22°C, larvae at hatching are 2.6 to 3.1 mm TL, and larvae reach swim-up at about 5.2 mm TL, some 4 days after hatching (Miller 1963; Colgan and Gross 1977; Hardy 1978). The cycle for the successful guardian male typically takes 10 days (range 6–15 days) with 2 days for territory establishment and nest construction, three for spawning and egg guarding, four for larval guarding, and one for fry dispersal and nest abandonment. Territoriality and aggressiveness in guardian males is highest during egg guarding and early larval stages, diminishing as larvae grow (Colgan and Gross 1977; Colgan and Brown 1988; Cooke *et al.* 2006). Males may lose on average 6.3% of their body weight from spawning to fry dispersal (Rios-Cardenas and Webster 2005). Females can participate in one to six spawning periods (average two to three) over a 7- to 8-week period, during which an estimated

12 to 40% of prespawning body mass is allocated to reproduction (Fox and Crivelli 1998). In lakes, fry apparently initially disperse offshore but return to littoral habitats in late summer (Keast 1978; Brown and Colgan 1984, 1985a; Mittelbach 1984a; Rettig 1998).

Nest associates: Golden shiner, *N. crysoleucas* (Shao 1997).

Freshwater mussel host: Confirmed host to *Alasmidonta varicosa*, *P. grandis*, and *U. imbecillis* (Trdan and Hoeh 1982; Fichtel and Smith 1995). Putative host to *Alasmidonta undulata*, *A. plicata*, *E. complanata*, *L. radiata*, *Lampsilis siliquoidea*, *L. reeviana*, *Lasmigona costata*, *L. recta*, *P. cataracta*, and *S. undulatus* (unpublished sources in OSUDM 2006).

Conservation status: The pumpkinseed is secure across most of its native range but is considered critically imperiled in Manitoba and vulnerable in Illinois (NatureServe 2006), which include the northwestern and southern peripheries of its native distribution, respectively (Page and Burr 1991).

Similar species: All other *Lepomis* have shorter, rounded pectoral fins, except the redear sunfish and bluegill. The redear sunfish and bluegill lack bold spots on the second dorsal fin and wavy blue lines on the gill cover (Page and Burr 1991).

Systematic notes: *Lepomis gibbosus* is basal to a clade consisting of *L. microlophus*, and the sister pair *L. punctatus*–*L. miniatus* (Near *et al*. 2004, 2005). Based on shared behavioral and morphological specializations for snail crushing, *L. gibbosus* was proposed previously as sister to *L. microlophus* (Bailey 1938; Mabee 1993). Frequencies of nuclear-encoded allozyme loci across populations in four east-central Ontario watersheds revealed low genetic variability, but populations were significantly substructured genetically. The patterns in genetic variation are congruent with hypothesized post-Pleistocene recolonization routes (Fox *et al*. 1997). Comparative studies of variation across the entire range of *L. gibbosus* are lacking, but anal and dorsal ray counts and differences in size and age at maturity show east to west differences (Scott and Crossman 1973; Fox *et al*. 1997).

Importance to humans: Although not often reaching a size of interest to many anglers, the pumpkinseed can contribute substantially to the sport fishery catch in northern lakes (e.g., Minnesota, Eddy and Underhill 1974; Wisconsin, Becker 1983), at least historically contributed to the Great Lakes commercial fishery catch (Scott and Crossman 1973), and is an easy and delightful catch for young anglers. The flesh is white, flaky, sweet, and delicious, comparable to that of the bluegill. The species can be taken in late afternoons with light tackle on live bait, small dry flies, poppers, or wet fly trout patterns (Scott and Crossman 1973; Eddy and Underhill 1974; Becker 1983). The pumpkinseed is important ecologically, forming part of the food for many predatory fishes including important game fishes (e.g., black basses, walleye, yellow perch, and muskellunge) (Scott and Crossman 1973). Among northern North American freshwater fishes, the pumpkinseed is among the most striking in beauty and color (Jordan and Evermann 1923; Becker 1983). Because of their color and ease of keeping and breeding, the species is a prized aquarium fish in Europe (Goldstein 2000).

13.8.4 Lepomis gulosus *(Cuvier)*

13.8.4.1 Warmouth

Characteristics: See generic account for general characteristics. Body relatively thick, robust, somewhat elongate, depth 0.4 to 0.5 of SL. Large, terminal oblique mouth, lower jaw projecting slightly, supramaxilla moderately large (>2 to ≤3 times length of maxilla), upper jaw extending well beyond anterior edge of eye to center of eye or beyond in adults. Dark red-brown lines (3–5) radiating posteriorly from snout and red eye. Opercular flap short, stiff, black with paler and often red-tinged border. Pectoral fin short and rounded, tip usually not reaching eye when laid forward across cheek. Long, thin gill rakers, 9 to 13, longest about four (adults) to six (young) times the greatest width. Lateral line complete. Lateral scales, 36 to 48; rows above lateral line, 6 to 9; rows below lateral line, 12 to 15; cheek scale rows, 5 to 7; caudal peduncle scale rows, 19 to 23; pectoral rays, 12 to 14. Pharyngeal arches narrow with bluntly conical teeth. Teeth on endopterygoid, ectopterygoid, palatine (villiform), and glossohyal (tongue, one patch) bones (Bailey 1938; Birdsong and Yerger 1967; Trautman 1981; Becker 1983; Etnier and Starnes 1993; Mabee 1993; Jenkins and Burkhead 1994; Boschung and Mayden 2004).

Size and age: Size at age 1 is highly variable among habitats and across latitudes, ranging from 25 to 155 mm TL (median 55.5 mm TL). Large individuals measure 150 to 200 mm TL, weigh about 200 g, and attain age 5 to 7+ (maximum 310 mm TL, age 8+) (Carlander 1977; Page and Burr 1991). World angling record, 1.1 kg, Florida (IGFA 2006).

Coloration: Ear flap short, black with yellow edges and posterior red spot (adult). Dark red-brown lines radiating from back of red eye. Olive brown above; dark brown mottling on back and upper side; often 6 to 11 chainlike dark brown bars on sides; cream to light yellow below; dark brown spots (absent on young) and wavy bands on fins. Breeding male boldly patterned on body and fins with a bright red-orange spot at base of second dorsal fin and black pelvic fins (Page and Burr 1991). Young and juveniles usually with a distinctive purplish sheen.

Native range: The warmouth is native to the Great Lakes and Mississippi River Basin from western Pennsylvania to Minnesota and south to the Gulf of Mexico and the Atlantic and Gulf drainages from the Rappahannock River, Virginia, to, but apparently not including, the Rio Grande, Texas, New Mexico, and Mexico (Page and Burr 1991; Miller 2005). The species is an apparent recent (ca. 1966) natural immigrant in the waters of southern Ontario, where it is naturalized (Crossman *et al.* 1996). The warmouth has been introduced widely and is established over much of the United States, including some Pacific Slope drainages (Fuller *et al.* 1999; Moyle 2002).

Habitat: The warmouth inhabits vegetated lakes, ponds, swamps, reservoirs, and quiet waters of slow-flowing streams, being most common, and often abundant, in lowland areas and rare in uplands (Larimore 1957; Holder 1970; Guillory 1978; Page and Burr 1991; Snodgrass and Meffe 1998). Individuals are most often solitary and usually associated with areas of dense vegetation, root wads, stumps, overhanging banks, or rock cavities over silt or mud substrates (Larimore 1957; Loftus and Kushlan 1987). Smaller warmouth (<127 mm TL) tend to remain in dense vegetation in shallow water, but larger individuals occur more often in deeper waters (Larimore 1957). Warmouth appear well adapted to the rigors of coastal plain wetland habitats of the southern United States. The species is tolerant of low DO levels and high turbidity, is adept at locating deep water refuge (e.g., alligator ponds) in response to seasonal drying of wetlands, and tolerates moderately brackish waters (<12.5 ppt) (Larimore 1957; Kushlan 1974; Loftus and Kushlan 1987; Killgore and Hoover 2001; Rutherford *et al.* 2001; Boschung and Mayden 2004). The physiological bases for or limits of these tolerances are unstudied. In a North Carolina swamp system, average movement for 20% of recaptured individuals was 5.0 km over 21 days. Notably, another 31% of recaptures moved 0.6 to 1.8 km (35–75 days at large), and 65% of marked individuals were never recaptured (Whitehurst 1981). Trap catches in the Okefenokee Swamp and Suwannee River suggested highest activity at night and peak movements in spring just before spawning (Holder 1970).

Food: The warmouth is a solitary, opportunistic predator whose large mouth allows it to feed on larger food items at a given body size than congeners. The size-adjusted gape area of the species is the largest among *Lepomis* (Collar *et al.* 2005a,b). The adult (>125 mm TL) diet consists primarily of small fish (e.g., sunfishes, darters, pickerels, killifish, mosquitofish), crayfish, and odonate larvae, but a variety of other taxa are consumed (e.g., freshwater shrimp, isopods, mayflies, caddisflies) (McCormick 1940; Chable 1947; Larimore 1957; Germann *et al.* 1974; Guillory 1978). The largest adults (>200 mm TL) often feed almost exclusively on crayfishes (Guillory 1978). Young warmouth transition from an initial diet of microcrustaceans to invertebrates (e.g., midge and caddisfly larvae) and at about 75 mm TL begin increasing use of the larger prey dominating the adult diet (Larimore 1957; Germann *et al.* 1974; Desselle *et al.* 1978; Guillory 1978). Dawn and dusk samples in the summer suggest that most feeding occurs at or before dawn with little feeding in the afternoon (Larimore 1957).

Reproduction: Maturity is reached at ages 1+ to 2+ at 57 to 152 mm TL (Larimore 1957; Germann *et al.* 1974; Guillory 1978). Spawning is initiated as water temperatures approach 21°C (as low as 15°C) and is protracted (April or May to July or August) with female ovary to body weight ratios peaking in late May to early June as water temperatures reach 27 to 29°C (Larimore 1957; Germann *et al.* 1974; Guillory 1978). Males excavate nests in a few hours by caudal sweeping, and depending on the time spent by the male, the nest may be a rather shapeless oval depression (about 10 cm × 20 cm) with only loose silt swept away or a deep, symmetrical circular depression (45 cm diameter, 13 cm deep). Nests are constructed at water depths of 15 to 152 cm (most <76 cm) and are often near simple cover (e.g., tree base, log, stump, boulder,) or on logs, roots, or mats of submerged plants. If available, small rocky substrates in silt-laden areas are chosen most often for nest sites and sand avoided, but in southern wetlands, nest bottoms often consist of tree leaves and needles swept free of silt. Bottom type appears less important than nearby cover for nest placement (Larimore 1957; Birdsong and Yerger 1967; Fletcher and Burr 1992). Nests are usually solitary (>4 m apart), but if habitat is limiting nests may be closely spaced (Carr 1940; Larimore 1957; Childers 1967). Courtship and spawning behaviors (based primarily on aquarium observations) appear typical for the genus (e.g., male aggressive displays, jaw gapes, opercular flares), but warmouth apparently do not rim circle; other than egg fanning by the male, no detailed observations are available on nest care or nest defense behaviors. During active courtship of a female, the body of a male becomes bright yellow and the eyes blood red in color, the change in colors requiring only 5 to 10 seconds. Only when the female is ready to lay eggs will she allow the male to guide her to the nest. In aquaria, a nest-guarding male will ultimately kill an unresponsive female (Larimore 1957). During paired circling of the nest (female near the center, male outside), the female jaw gapes a few times, violently jerks her body, and releases about 20 eggs while simultaneously thumping the male on the side in an apparent signal for him to release sperm. These behaviors are repeated sequentially for about 1 hour with brief pauses in between bouts, at which time males may use caudal sweeping to mix eggs into the substrate (Larimore 1957). Mature ovarian eggs (water-hardened) average 1.01 mm in diameter (Merriner 1971a). Mature females contain two or more egg class sizes throughout the spawning season (Larimore 1957; Germann *et al.* 1974). Batch fecundity increases with female size. The relationship between batch fecundity (Y) and total length (X) is described by the linear function, $\log_{10} Y = -1.6108 + 2.4859 \log_{10} X$ (data from mean number of mature eggs of nine length classes, $R^2 = 0.85$, Germann *et al.* 1974). At 195 mm TL, a female can potentially produce 12,078 mature eggs in a single batch (range: 6825 eggs at 155 mm TL to 20,238 eggs at 240 mm SL, respectively). Another estimate of batch fecundity is much lower (i.e. $\log_{10} Y = 0.1619 + 1.418 \log_{10} X$; where X is SL, Guillory 1978). The fertilized eggs are pale, amber-colored, and adhesive, hatching in about 1.5 days at 25.0 to 26.4°C (71.1 hours at 22.6°C, 33.9 hours at 26.9°C, and 32.5 hours at 27.3°C). Larvae at hatching are 2.3 to 2.9 mm TL and reach swim-up at about 4.7 to 7.6 mm TL, some 3 to 5 days after hatching (Larimore 1957; Childers 1967). After leaving the nest, young apparently do not form schools, but hide themselves in dense vegetation or other cover. Likewise, juvenile warmouth do not aggregate in large groups (Larimore 1957).

Nest associates: Bluehead shiner, *Pteronotropis hubbsi* (Fletcher and Burr 1992).

Freshwater mussel host: Confirmed host to *A. suborbiculata*, *L. subrostrata*, *Toxolasma texasensis*, and *U. imbecillis* (Stern and Felder 1978; Barnhart and Roberts 1997). Putative host to *T. parvus* (unpublished sources in OSUDM 2006).

Conservation status: The warmouth is currently stable over most of its range (Warren *et al.* 2000; NatureServe 2006). Peripheral populations in Pennsylvania and West Virginia are considered imperiled, and recently naturalized populations in Ontario are listed as critically imperiled (NatureServe 2006), although the necessity for the latter status has been questioned (Crossman *et al.* 1996).

Similar species: The green sunfish lacks dark lines radiating posteriorly from eye, lacks teeth on the tongue, and has a dark spot at the posterior base of the second dorsal fin (Page and Burr 1991).

Systematic notes: *Lepomis gulosus* is basal to the sister pair *L. symmetricus* and *L. cyanellus* (Near *et al.* 2004, 2005). Mitochondrial DNA analyses revealed distinct eastern and western populations of *L. gulosus*, occurring along the Atlantic Slope through Florida to eastern tributaries of Mobile Basin and from the Tombigbee River westward, respectively (Bermingham and Avise 1986). *L. gulosus* has a checkered taxonomic and nomenclatural history (summary in Berra 2001), but comparative studies of variation across the range of the species are lacking.

Importance to humans: Over much of its range, the warmouth is taken most often by bream or crappie anglers but usually not in abundance. Even so, warmouth can comprise a large part of the sport fish catch in habitats like the Okefenokee Swamp, Georgia, or Reelfoot Lake, Tennessee (Larimore 1957; Germann *et al.* 1974). Warmouth are quick to take an artificial lure or live bait. The species is an excellent table fish, the flavor and texture of the flesh being judged as intermediate between the bluegill and the largemouth bass (Larimore 1957).

13.8.5 Lepomis humilis *(Girard)*

13.8.5.1 Orangespotted sunfish

Characteristics: See generic account for general characteristics. Body moderately deep, compressed, slab-sided, depth 0.38 to 0.45 of SL. Mouth moderately large, oblique, supramaxilla absent, upper jaw extends to, or just beyond, anterior edge of eye. Orange or red-brown wavy lines on cheek and opercle in adults. Opercular flap moderate to long (in adults), very flexible, usually angled upward with black center and wide, white to pale green, conspicuous border (flushed with orange in breeding males). Pectoral fin short and rounded, tip usually not reaching eye when laid forward across cheek. Moderately thin gill rakers, 10 to 15, longest about five times greatest width. Enlarged, elongate sensory pits on preopercle and head between eyes, pits larger than any other *Lepomis*, width of each pit about equal to distance between pits. Lateral line complete or incomplete. Lateral scales, 32 to 42; cheek scale rows, 5; pectoral rays, 13 to 15. Pharyngeal arches narrow with sharply pointed teeth. Teeth on palatine bone. No teeth on endopterygoid, ectopterygoid, or glossohyal (tongue) bones (Bailey 1938; Trautman 1981; Becker 1983; Mabee 1993; Ross 2001; Boschung and Mayden 2004).

Size and age: Size at age 1 is highly variable among habitats and across latitudes, ranging from 23 to 86 mm TL (median 45 mm TL). Large individuals measure 75 to 125 mm TL, weigh <60 g, and attain age 3+ (maximum 177 mm TL, about 150 g, age 4+) (Barney and Anson 1923; Carlander 1977; Page and Burr 1991; TWRA 2006).

Coloration: Black ear flap, usually angled upward, with conspicuous wide white, pale green, pale lavender, pinkish, or light crimson border. Olive above with bright orange (large male) or red-brown (female) spots on silver-green side. Orange (male) or red-brown (female) wavy lines on cheek and opercle. White to orange below; fins unspotted. Young with chainlike vertical bars and no spots on side. Breeding male brilliantly colored with red-orange spots on side; reddish orange eye, belly, anal fin, and dorsal fin edge; pelvic fins white to orange with black edge (Noltie 1990; Page and Burr 1991; Etnier and Starnes 1993).

Native range: The orange-spotted sunfish is native to southwestern Lake Erie and Lake Michigan, the extreme headwaters of the Red River of the North (Hudson Bay drainage), and the Mississippi River Basin from Ohio to southern North Dakota and south to Louisiana and in Gulf Slope drainages from the Mobile Basin, Alabama, to the Colorado River, Texas (Page and Burr 1991). In historical times, the species expanded its range into southeastern Michigan and adjacent Ontario, northward in Wisconsin, and eastward across Indiana and Ohio, as agricultural activities converted formerly clear prairie-type streams into turbid plains-type streams (Trautman 1981; Holm and Coker 1981; Becker 1983; Noltie 1990; Bailey *et al.* 2004). The species has been introduced sporadically on the periphery of its native range, usually unintentionally as stock contaminant with other centrarchids (Fuller *et al.* 1999).

Habitat: The orangespotted sunfish inhabits quiet pools of creeks and small to large, often turbid, rivers, as well as overflow swamps and backwaters of sluggish streams, natural lakes, and reservoirs (Noltie 1990; Page and Burr 1991; Etnier and Starnes 1993; Miranda and Lucas 2004). The species is rarely abundant but is most common in low-gradient habitats. The orangespotted sunfish is among the most tolerant of *Lepomis* to adverse conditions of low DO (<1 ppm) and high temperatures (average critical thermal maxima 36.4°C, acclimated at 26°C) (Matthews 1987; Smale and Rabeni 1995a; Beitinger *et al.* 2000).

Food: The orangespotted sunfish is an opportunistic invertivore, feeding extensively on midge larvae, caddisfly larvae, hemipterans, and microcrustaceans, rarely consuming small fish (Barney and Anson 1923; Clark 1943; Noltie 1990). These primary diet items, along with aerial insects in stomachs, indicate both bottom and surface feeding (Clark 1943; Etnier and Starnes 1993). When exposed to different diets, orangespotted sunfish show subtle but measurable changes in morphology, primarily in head shape, suggesting diet as a strong determinant of trophic morphology (Hegrenes 2001).

Reproduction: Maturity is reached at ages 1+ to 2+ at 30 to 50 mm TL (Barney and Anson 1923; Noltie 1990). Spawning is initiated as water temperatures approach 18°C and is protracted (April or May–late August) beginning 6 weeks earlier at southern (e.g., Louisiana) than at northern (e.g., Iowa) latitudes. Spawning is reported across a range of water temperatures from 24 to 32°C (Barney and Anson 1923; Cross 1967; Becker 1983; Noltie 1990). Ripe males and females are taken throughout the summer months. Scale growth increments suggest that fish hatched early in the spawning season obtain sexual maturation in August of the second year of life (age 1+) and those hatched latter delay maturation to early summer of the third year of life (age 2+) (Barney and Anson 1923). Males build nests at water depths of 30 to 61 cm, using caudal sweeping, pushing with the head, and fin undulations to remove overlying silt and mud, to ultimately form semicircular depressions about 15 to 18 cm in diameter and 30 to 40 mm deep with firm, exposed bottoms. Nests are colonial (<1.0 m apart) with males defending a territory of 30 to 60 cm (Barney and Anson 1923; Miller 1963; Cross 1967). Males actively court females by repeatedly rushing out to them and rapidly returning to the nest, while producing a series of gruntlike sounds (Gerald 1971). Other courtship, spawning, and nest-guarding behaviors appear typical for the genus (e.g., male aggressive displays, rim circling, egg fanning), but few detailed observations are available (Barney and Anson 1923; Miller 1963). Fecundity increases with female size, but it is unclear if available egg counts were based on total or mature ova in females (Barney and Anson 1923; Becker 1983). The relationship between fecundity (Y) and total length (X) is described by the linear function, $\log_{10} Y = -2.2596 + 2.9785 \log_{10} X$ (data from Barney and Anson 1923, $n = 28$, $R^2 = 0.80$, four likely partially spent females deleted). At 68 mm TL, a female can potentially produce 1580 eggs in a single batch (range: 138 eggs at 30 mm TL to 5776 eggs at 105 mm TL). The nearly transparent, amber to colorless, fertilized eggs are about 0.5 to 1.0 mm in diameter and hatch in about 5 days at 18.0 to 21.0°C (Barney and Anson 1923; Cross 1967; Becker 1983). Yolk-sac larvae and larvae (ages unstated) are 5.3 and 7.0 mm TL, respectively (Tin 1982). A reported hatching size of 10 mm TL (Barney and Anson 1923) seems much too large and needs verification.

Nest associates: Red shiner, *C. lutrensis* (Pflieger 1997) and redfin shiner, *L. umbratilis* (Snelson and Pflieger 1975; Trautman 1981).

Freshwater mussel host: Confirmed host to *A. ligamentina, E. complanata, L. complanata, L. recta*, and *P. grandis* (Young 1911; Arey 1932). Putative host to *L. compressa* and *T. parvus* (unpublished sources in OSUDM 2006).

Conservation status: The orangespotted sunfish is secure throughout much of its native range (e.g., Warren *et al.* 2000), but peripheral populations in Michigan, West Virginia, and southwestern Ontario are considered imperiled (NatureServe 2006).

Similar species: Other *Lepomis* with orange spots on the side have dark (blue or olive brown) sides and lack the wide white edge on the ear flap, the elongated sensory pores on the preopercle, and the enlarged sensory pores on top of the head (Page and Burr 1991).

Systematic notes: *Lepomis humilis* forms a sister pair with *L. macrochirus* (Near *et al.* 2004, 2005). This sister pair represents the second smallest and the largest species, respectively, in the genus and interestingly, display near complete overlap in their geographic ranges (Page and Burr 1991; Near *et al.* 2004). Comparative studies of variation across the range of *L. humilis* are lacking.

Importance to humans: The orangespotted sunfish does not reach a size of interest to most anglers. The species is reportedly a good bioassay animal and aquarium fish (Becker 1983; Schleser 1998), and ecologically, is suggested as a natural biological control for mosquitoes (Barney and Anson 1923).

13.8.6 Lepomis macrochirus *Rafinesque*

13.8.6.1 Bluegill

Characteristics: See generic account for general characteristics. Deep, compressed body, depth 0.43 to 0.56 of SL. Mouth small, strongly oblique, supramaxilla absent, upper jaw rarely reaches anterior edge of eye. Large black spot at posterior of soft dorsal fin. Opercular flap moderate to long, flexible, black at margins, lacks distinct pale or light edges. Pectoral fin long and pointed, tip usually reaches past eye when laid forward across cheek. Long, slender gill rakers, 13 to 16, longest about four to five times the greatest width. Lateral line complete. Lateral scales, (38)41 to 46(50); rows above lateral line 7 to 9; rows below lateral line, 14 to 17; cheek scale rows, 4 to 7; caudal peduncle scale rows, 18 to 21; pectoral rays, 12 to 15. Pharyngeal arches moderately wide with thin, sharply pointed teeth. Teeth present or absent on palatine. No teeth on endopterygoid, ectopterygoid, or glossohyal (tongue) bones (Bailey 1938; Keast and Webb 1966; Trautman 1981; Becker 1983; Mabee 1993; Jenkins and Burkhead 1994; Boschung and Mayden 2004).

Size and age: Size at age 1 is highly variable among habitats and across latitudes, ranging from 18 to 122 mm TL (median 51 mm TL) (Carlander 1977). Interestingly, mean size by fall of age-0 bluegill in lakes is the same across a broad range of latitudes (ca. 55 mm TL), suggesting that northern bluegill grow as rapidly in the first summer as southern bluegill (Garvey *et al.* 2003). Local factors, such as abundance of specific prey types (cladocerans versus invertebrates), proportion of littoral habitat, and exploitation can differentially affect growth in small (ca. 50 mm TL) and large bluegills (Shoup *et al.* 2007). Large individuals can exceed 200 mm TL, 200 g, and attain age 6+ to 7+, although individuals in northern populations tend to live longer than their faster growing southern counterparts (maximum about 410 mm TL, 567 g, and age 11+) (Carlander 1977; Page and Burr 1991). World angling record, 2.15 kg, Alabama (IGFA 2006). Parental males grow faster than females and show subtle, but detectable differences in body shape (deeper bodied, longer paired fins) (Ehlinger 1991). Cuckolder, nest-parasitic males grow slower and mature earlier than parental males (Dominey 1980; Gross 1982; Drake *et al.* 1997; Ehlinger 1997; Ehlinger *et al.* 1997).

Coloration: Ear flap, short to moderately long, black to margin. Large black spot at rear of second dorsal fin. Dark bars (chainlike in young and absent in turbid water) or plain sides on body. Adult with blue sheen overall and two blue streaks from chin to edge of gill cover. Olive back and side with yellow and green flecks; paler on belly to brassy yellow on breast; clear to dusky fins. Breeding male with blue, blue-olive, or blue-green head and back; red-orange breast; black pelvic fins (Page and Burr 1991; Jenkins and Burkhead 1994).

Native range: The bluegill is native to the St. Lawrence-Great Lakes system and Mississippi River Basin from Quebec and New York to Minnesota and south to the Gulf of Mexico and in Atlantic and Gulf Slope drainages from the Cape Fear River, Virginia, to the Rio Grande River, Texas and Mexico (Page and Burr 1991; Miller 2005). The species has been widely introduced and is now established and often exceedingly abundant in suitably warm waters of most of North America (Fuller *et al.* 1999; Moyle 2002; Miller 2005) and other continents (e.g., South Africa, Korea, Japan), where because of stunting and competition with native fishes, the species is often considered a pest (De Moor and Bruton 1988; Jang *et al.* 2002; Kawamura *et al.* 2006). Nonnative bluegills are implicated in the decline of the native Sacramento perch in California and other native fishes in the western United States (Marchetti 1999; Moyle 2002).

Habitat: The bluegill inhabits all types of warmwater lacustrine habitats (e.g., oligohaline estuaries, swamps, lakes, ponds, reservoirs, canals) as well as pools of creeks and small to large rivers. In lacustrine environments, whether natural or man made, the bluegill is often the most abundant centrarchid (Desselle *et al.* 1978; Becker 1983; Page and Burr 1991; Peterson and Ross 1991; Jenkins and Burkhead 1994). The species is among the most tolerant *Lepomis* to adverse conditions of low DO (<1.0 ppm) and high temperatures (average critical thermal maxima 40.4–41.4°C, acclimated at 35°C) (Moss and Scott 1961; Matthews 1987; Smale and Rabeni 1995a,b; Beitinger *et al.* 2000; Miranda *et al.* 2000; Killgore and Hoover 2001). However, RNA–DNA ratios indicate bluegill from hypoxic habitats (1.22–3.04 mg/l DO, always <2 mg/l at night) show reduced growth relative to individuals from normoxic habitats (>3.2 mg/l at night) (Aday *et al.* 2000). Bluegill can survive winter conditions of <1°C and <2 mg/l DO (Magnuson and Karlen 1970; Petrosky and Magnuson 1973; Knights *et al.* 1995), but winter anoxia, often associated with iceover of shallow lakes, limits their distribution in northern lakes (Tonn and Magnuson 1982; Rahel 1984). Bluegill indigenous to fresh or brackish waters showed no preference in salinity over a range of 0 to 10 ppt (Peterson *et al.* 1993). Coastal juvenile bluegill showed no influence on growth or osmoregulatory characteristics (e.g., hematocrit activity) at 10 ppt salinities and fed diets containing up to 4% NaCl (Musselman *et al.* 1995).

Home activity area of bluegills in streams generally extends about 50 to 500 linear meters, and marked individuals are often recaptured in the same stream section throughout the summer or even over multiple seasons or years (Gunning and Shoop 1963; Whitehurst 1981; Gatz and Adams 1994). Although observed in few individuals, bluegills ranged as far as 17 linear km in Tennessee streams. About 20% of successive recaptures were ≥250 m apart over 4 years (Gatz and Adams 1994), and in a North Carolina swamp stream bluegills moved 3.4 km in 33 days (Whitehurst 1981). Home range of radio-tagged bluegill (>160 mm TL) over summer and early fall in an Illinois lake ranged from 0.15 to 0.72 ha (occupied from 12–34 days) with core use areas of 0.11 to 0.60 ha (Fish and Savitz 1983). Large, radio-tagged bluegill (>200 mm TL) tracked from April to September in a shallow Great Plains lake showed no difference in diel activity patterns or habitat use and showed low site fidelity, except during spawning (Paukert and Willis 2002; Paukert *et al.* 2004). Home areas ranged from 0.13 to 172 ha (core areas of 0.01 to 27.2 ha); individuals moved up to 1.1 km/h, but most rates of movement ranged from 30 to 100 m/h. Bluegills (40 to 125 mm TL) shifted from using the mid-depth zone (1.5–6.0 m) in summer to wintering in the shallow (<1.5 m) vegetated littoral zones of a Florida lake (Butler 1989), may move onshore after sunset and offshore after sunrise (Baumann and Kitchell 1974; Helfman 1981), and may emigrate in fall to avoid extreme winter conditions (Knights *et al.* 1995; Parsons and Reed 2005).

Food: The bluegill is a generalist, travel-and-pause predator that can routinely exploit zooplankton in pelagic habitats and larger vegetation-dwelling invertebrates in littoral habitats (Werner *et al.* 1981, 1983; Ehlinger and Wilson 1988; Schramm and Jirka 1989; Dewey *et al.* 1997). The adult diet consists of an array of invertebrates including amphipods, cladocerans, larval dipterans, mayflies, and odonates, and terrestrial insects (e.g., McCormick 1940; Chable 1947; Seaburg and Moyle 1964; Applegate *et al.* 1967; Etnier 1971; Sadzikowski and Wallace 1976; Werner 1977; Schramm and Jirka 1989; Dewey *et al.* 1997; VanderKooy *et al.* 2000). Notably, bluegill shift from pelagic zooplanktivory to littoral invertivory at small sizes (12–15 mm SL), and then can shift back to zooplanktivory after a period of growth (>80 mm SL) (Werner 1969; Werner and Hall 1988; Rettig 1998). Surprisingly for a primarily diurnal feeder, laboratory-measured activity in bluegill decreased shortly after dawn, peaked about 1.5 hours after darkness, and remained above daylight levels throughout most of the night (Langley *et al.* 1993; see also Reynolds and Casterlin 1976a; Shoup *et al.* 2003). Diet studies indicate that nighttime feeding can be minimal with peak feeding often occurring after sunrise and at dusk (Sarker 1977; Keast and Fox 1992), but foraging in summer can be nearly continuous over a 24-hour period (Seaburg and Moyle 1964; Keast and Welsh 1968; Sarker 1977; Dewey *et al.* 1997). Peak feeding times are size mediated, occurring latter in the day for smaller (<95 mm) than larger individuals (105–135 mm TL) (Baumann and Kitchell 1974).

The bluegill is an effective, adaptive predator. The species uses a highly stereotyped travel-and-pause foraging tactic, which is combined with a generalist but plastic morphology and an elaborate behavioral flexibility. These traits allow bluegills to switch foraging habitats, quickly learn new foraging behaviors (e.g., increased pause duration, faster pursuit), and successfully exploit new prey in response to changes in prey abundance, intraspecific and interspecific competition, or predation risk (e.g., Werner and Hall 1974, 1977, 1979, 1988; Mittelbach 1981, 1984b; Gotceitas and Colgan 1987, 1988; Ehlinger 1989, 1990; Colgan *et al.* 1981; Gotceitas 1990a,b; Wildhaber and Crowder 1991; Dugatkin and Wilson 1992; Mittelbach and Osenberg 1993; Rettig and Mittelbach 2002; Shoup *et al.* 2003). Intense, often selective, predation by bluegills can directly affect the size, abundance, and composition of zooplankton, which indirectly alters the density and composition of phytoplankton communities (Vanni 1986; Hambright *et al.* 1986; Mittelbach and Osenberg 1993). Similarly, bluegill predation on macroinvertebrates includes reductions in the biomass, abundance, and size of invertebrates and is often influenced by complex interspecific interactions with other centrarchids and size-mediated interactions with conspecifics (Crowder and Cooper 1982; Morin 1984a,b; Mittelbach 1988; McPeek 1990; McPeek *et al.* 2001; Rettig and Mittelbach 2002). The presence of the bluegill also can have dramatic effects on predator avoidance and other behaviors of amphibians (Jackson and Semlitsch 1993; Werner and McPeek 1994).

In a mutualistic feeding role, bluegills serve as facultative cleaners by picking off ectoparasites, loose scales, and necrotic tissue from a host (i.e. other bluegill, *Micropterus* spp., striped mullet, *Mugil cephalus*, manatees, and perhaps large ictalurids) (Spall 1970; Sulak 1975; Powell 1984; Loftus and Kushlan 1987; Moyle 2002). Multiple observations tend to occur in the same locations, suggesting that bluegill establish permanent cleaning stations as documented in marine fishes. In the Everglades, groups of bluegills follow alligators through the water and trail closely behind lake chubsuckers (*Erimyzon sucetta*) as they forage along the bottom, presumably feeding on prey disturbed by these animals (Loftus and Kushlan 1987). Bluegills also join similar-sized Florida bass and together they group hunt for small fishes in clumps of vegetation (Annett 1998).

The bluegill is well equipped visually to detect small or mobile prey (Hairston *et al.* 1982; Williamson and Keast 1988). In ample light (>10^{-6} W/cm^2), bluegill can detect prey items 0.3 to 0.7% brighter than the visual background (Hawryshyn *et al.* 1988) with greatest detection ability in a forward-projecting pie-shaped wedge in the horizontal plane of the fish (Walton *et al.* 1994). Visual acuity increases by about 50% as bluegill increase in size from 35 to 60 mm SL (Hairston *et al.* 1982), but the rate of increase in acuity diminishes in fish >60 mm SL (Breck and Gitter 1983; Li *et al.* 1985; Walton *et al.* 1992, 1994, 1997). Increased acuity with growth confers visual access to increasing volumes of search space, and the ability to see increasing numbers of prey (Vinyard and O'Brien 1976; Gardner 1981; Hairston *et al.* 1982; Breck and Gitter 1983; Walton *et al.* 1994). For example, estimated visual and search volumes of bluegill viewing a 2-mm zooplankter increase by nearly three orders of magnitude from about 0.1 l at 8 mm SL to 90 l at 50 mm SL (Walton *et al.* 1994); the estimated visual volume more than doubles from 200 to >400 l for a 3-mm zooplankton target as fish size increases from 60 to 160 mm TL (Breck and Gitter 1983).

Decreased light or increased turbidity dramatically influences feeding (and predator detection) in bluegills. Below illuminance of 10 lux, reactive distance to small zooplankton prey (1–3 mm) decreases at successively lower light levels, such that regardless of prey size, reactive distances at low light (0.7 lux) are reduced to 3 to 4 cm (Vinyard and O'Brien 1976). Similarly, reactive distances to a larger visual target (largemouth bass, 290 mm TL) decrease from about 175 cm at 3340 lux to <50 cm at 1.5 lux (Howick and O'Brien 1983). In ample light and clear water, bluegills (and perhaps other *Lepomis*) can recognize an object as prey (or predator) at greater distances than do largemouth bass (Howick and

O'Brien 1983; Miner and Stein 1996). As light decreases to twilight levels, bluegills >40 mm TL lose their reactive distance advantage over largemouth bass such that only smaller bluegills can locate largemouth bass first under low light intensities (Howick and O'Brien 1983). Under constant light, detection ability of bluegills decreases as a log or exponential function of increasing turbidity for small zooplankton prey and large predators, respectively, but interactions of light and turbidity with feeding success are complex (Vinyard and O'Brien 1976; Gardner 1981; Miner and Stein 1993).

Bluegills show subtle differences in intrapopulation body morphology. In lakes, differences in body morphology are associated with foraging and predator avoidance in littoral or open-water habitats. Bluegills from littoral habitats have deeper bodies, longer paired fins, and more posteriorly attached pectoral fins than those in open water (Ehlinger and Wilson 1988; Chipps *et al*. 2004). The open-water form also has a modified foraging behavior (decreased pause duration) (Ehlinger 1990). Relative to the littoral form, the open-water form shows increased predator avoidance behaviors (i.e. schooling defense), but in cover, predators take three times longer to capture the littoral form than the open-water form (Chipps *et al*. 2004).

The feeding behavior and ecology of the bluegill are among the most extensively documented of any North American freshwater fish. Only a cursory review of this important body of literature is possible here. The interested reader is encouraged to consult papers cited herein and others, including, for example, Werner (1974), O'Brien *et al*. (1976), Werner *et al*. (1977), Bulow *et al*. (1978, 1981), Keast (1978, 1985a,b,c), Vinyard (1980), Savino and Stein (1982, 1989a,b), Mittelbach (1983), Brown and Colgan (1986), Butler (1988), Johnson *et al*. (1988), Osenberg *et al*. (1988, 1992), DeVries *et al*. (1989), DeVries (1990), Gotceitas and Colgan (1990), Savino *et al*. (1992), Schaefer *et al*. (1999), Harrel and Dibble (2001), Wildhaber (2001), Yonekura *et al*. (2002), McCauley (2005), and Spotte (2007).

Reproduction: Maturity varies with sex, male alternative life history strategy, intraspecific competition, and latitude and can be reached at age 0+ (first summer of life) to age 6+ at a minimum size of about 73 to 172 mm TL and 15 to 82 g (Morgan 1951a,b; Carlander 1977; Gross 1982; Ehlinger *et al*. 1997). Time of maturation between the sexes can vary greatly even among lakes at similar latitudes, and cuckolder males within populations mature at an earlier age and size than parental males (Gross 1982; Ehlinger 1991; Drake *et al*. 1997). In ponds, small male bluegill are inhibited from maturing in the presence of large males, regardless of food availability, and laboratory evidence suggests that large parental males produce a pheromone that inhibits maturation in small males (Aday *et al*. 2003, 2006). Increased photoperiod (12–16 hours) and rising temperature in the spring controls prespawning gonadal development (Banner and Hyatt 1975; Mischke and Morris 1997). Spawning is protracted (mid-May–mid-August) (Morgan 1951a,b; Avila 1976; Gross 1982), particularly in southern Florida where reproduction extends from late February or early March through September with pauses in activity for up to 3 weeks (Clugston 1966). Nest building and spawning begin as water temperatures increase to 20°C, and spawning continues up to about 31°C (Morgan 1951a,b; Banner and Hyatt 1975); males in stunted populations initiate nest building several weeks later than males in nonstunted populations (Jennings *et al*. 1997; Aday *et al*. 2002). Males excavate saucer-shaped depressional nests hy caudal sweeping (Morgan 1951a,b; Miller 1963; Avila 1976; Gross 1982), which alters substrate composition by removing small particles (<2 mm) to expose hard substrates or larger coarse gravel and pebble substrates (>8 mm diameter). Coarse nest substrates are associated with increased survival of fry (Bain and Helfrich 1983). Nests are placed in open, shallow areas (10–190 cm water depth, rarely >3.0 m), usually away from cover (Carhine 1939; Morgan 1951b; Clugston 1966; Avila 1976; Ehlinger 1999). Median depths of nest placement suggest that males may be able to sense ultraviolet radiation, and place nests deeper in high underwater ultraviolet radiation environments, which can damage developing embryos (Gutiérrez-Rodriguez and Williamson 1999). Bluegills nest in crowded colonies that can contain hundreds of abutting nests, and these colonies often contain other nesting *Lepomis* spp. (Childers 1967; Avila 1976; Gross 1982; Cargnelli and Gross 1996). In colonies, spawning events (five to eight per spawning season) are synchronous, occurring at intervals of 10 to 14 days; males may nest one or more times in a season (Neff and Gross 2001), and females presumably participate in multiple spawning events. Colony formation is a definite social aggregation because it occurs in the absence of habitat limitation (Gross and MacMillan 1981). Colonial nesting affords decreased predation on offspring through cumulative nest defense (e.g., predator mobbing, Dominey 1981, 1983; Gross and MacMillan 1981) and decreased fungal infection of eggs (Côté and Gross 1993), both of primary benefit to parental males located centrally rather than peripherally in a colony (Neff *et al*. 2004). Nevertheless, a consistent but small proportion of bluegill males within a population nest solitarily (Avila 1976; Ehlinger 1999; Neff *et al*. 2004). These males are in hetter condition than colonial males but possess smaller ear tabs than centrally located males. Solitary nesters experience decreased cuckoldry relative to colonial males and show a nesting success equivalent to centrally located males, but higher success than peripherally located males (Gross 1991; Neff *et al.* 2004), suggesting that females do not discriminate between solitary and central males. Guardian males produce gruntlike sounds as part of courtship of females and aggression toward conspecific and other *Lepomis* males (Gerald 1971; Ballantyne and Colgan 1978a,b,c). Other male courtship, spawning, and nest defense behaviors are well documented and typical for the genus (e.g., aggressive displays, courtship circles, rim circling, paired nest circling, egg fanning) (e.g., Morgan 1951b; Miller 1963; Avila 1976; Colgan *et al.* 1979; Gross 1982; Clarke *et al.* 1984; Coleman *et al.* 1985; Coleman and Fischer 1991; Stoltz and Neff 2006). On the female entering a nest, a 15- to 90-minute spawning bout ensues in which the female releases small groups of eggs in a series of dips into the nest; females may dip hundreds of times during a bout (Avila 1976; Gross 1991; Fu *et al.* 2001). Males control the rate of dips by biting the female (Gross 1991). Males mate sequentially with several females (rarely with two females simultaneously) during synchronous spawning events (usually <1 day), resulting in accumulations of 4600 to 61,000 eggs/nest (Carbine 1939; Avila 1976; Gross 1982, 1991; Cargnelli and Gross 1996). Although discouraged by the male, spawning females frequently succeed in eating a portion of their predecessor's eggs (Gross and MacMillan 1981). Mature ovarian eggs average from 1.09 to 1.30 mm diameter and fertilized, water-hardened eggs 1.2 to 1.4 mm in diameter (Morgan 1951b; Meyer 1970; Merriner 1971a; Hardy 1978; Gross and Sargent 1985; Cooke *et al.* 2006). Fecundity increases with female size. The relationship between potential batch fecundity (Y) and total length (X) is described by the linear function, $\log_{10} Y = -3.39794 + 3.4512 \log_{10} X$ (mean numbers of 18 length class means for 91 females, $R^2 = 0.83$, data from Morgan 1951b). At 165 mm TL, a female can potentially produce 17,990 mature eggs in a single batch (range: 5021 eggs at 114 mm TL to 45,575 eggs at 216 mm TL, respectively). The adhesive, fertilized eggs hatch in 2.1 days at 23.8°C (1.3 days at 27.1°C) (Childers 1967). Newly hatched larvae are 2.2 to 3.7 mm TL, and depending on temperature, larvae are free swimming about 3 to 4 days after hatching at a size of 4.30 to 5.70 mm TL (Childers 1967; Meyer 1970; Anjard 1974; Taubert 1977). Fry size at dispersal is correlated negatively with spawn date and hence, varies within a single population and spawning season (e.g., 4.3–6.7 mm) (Cargnelli and Gross 1996). Males guard and vigorously defend the nest, eggs, and larvae for about 7 days, but earlier abandonment of nests is common (see subsequent, Neff and Gross 2001; Neff 2003ab). Relatively large decreases in body weight (about 11%) and declines in lipid energy reserves occur in guardian males during the parental care period when feeding is reduced or curtailed (Avila 1976; Coleman *et al.* 1985; Coleman and Fischer 1991). During nest guarding, males with large broods sustain egg fanning for longer periods and more intensively defend the fry than males with small broods (Coleman *et al.* 1985; Coleman and Fischer 1991).

Alternative mating strategies are highly developed in male bluegills. Both sneaker and satellite male morphs are only known in a single well-studied population of bluegill in Lake Opinicon, Ontario (Gross 1982), and presumable satellite equivalents (female mimics) were described from a New York lake (Dominey 1980). However, sneaker male morphs occur widely in populations of bluegill (Ehlinger 1997; Drake *et al.* 1997). Parasitic males can outnumber parental males 6:1, are excellent sperm competitors (80% fertilization rate), and are preferred by females, which release up to three times more eggs with the cuckolder than if alone with the guardian male (Fu *et al.* 2001; Neff 2001; Burness *et al.* 2004). Cuckolders reduce guardian male paternity in colonies by as much as 40% (average 23.1%), but their proportion of successfully fertilized eggs, relative to guardian males, decreases in colonies as their frequency reaches and exceeds numbers optimizing their fertilization success (Gross 1991; Philipp and Gross 1994). In an evolutionary response to intense cuckolding, guardian male bluegill apparently assess perceived paternity during the egg guarding stage through visual cues (presence of sneakers), and if perceived sneaker paternity is high, the guardian male decreases egg care or even abandons and cannibalizes eggs shortly after spawning (Neff and Gross 2001; Neff 2003a,b). Later in the brood-guarding phase, the guardian male apparently assesses actual paternity (combined sneaker and satellite male fertilizations) through olfactory cues released by hatchlings and again adjusts his level of parental care, often resulting in a second wave of filial cannibalism and brood abandonment if actual cuckolding is high (Neff and Gross 2001; Neff and Sherman 2003, 2005; Neff 2003a,b). Given that guardian males can distinguish their fry from unrelated offspring (Neff and Sherman 2003), they may be able to selectively forage on unrelated fry while continuing to provide care to their fry (Neff 2003b).

Nest associates: Golden shiner, *N. crysoleucas* (DeMont 1982).

Freshwater mussel host: Confirmed host to *Amblema neislerii*, *A. plicata*, *Elliptio buckleyi*, *Elliptio fisheriana*, *Elliptio icterina*, *Fusconaia masoni*, *G. rotundata*, *L. bracteata*, *L. cardium*, *L. higginsii*, *L. siliquoidea*, *Lampsilis straminea claibornensis*, *M. nervosa*, *P. grandis*, *S. undulatus*, *U. imbecillis*, *Villosa lienosa*, and *Villosa villosa* (Howard 1914, 1922; Coker *et al.* 1921; Penn 1939; Trdan and Hoeh 1982; Parker *et al.* 1984; Waller and Holland-Bartels 1988; Hove *et al.* 1997; Howells 1997; Keller and Ruessler 1997; O'Dee and Watters 2000; O'Brien and Williams 2002; Rogers and Dimock 2003). Putative host to *Anodontoides ferussacianus*, *E. complanata*, *E. hopetonensis*, *L. reeveiana*, *Lampsilis satura*, *L. teres*, *L. compressa*, *L. costata*, *L. recta*, *Pleurobema sintoxia*, and *T. parvus* (unpublished sources in OSUDM 2006).

Conservation status: The bluegill is secure throughout its range (Warren *et al.* 2000; NatureServe 2006). The morphological and genetic variation across the entire native range of this fish is poorly known, despite its considerable importance in fisheries management and compelling evidence of geographic differentiation (e.g., Avise and Smith 1974, 1977; Felley and Smith 1978; Felley 1980). Further, the species is still widely stocked with little or no concern for brood stock origin or effects on genetic integrity of native bluegill stocks or other native fishes.

Similar species: The redear sunfish lacks a large, dark spot in the second dorsal fin and has a red edge on the ear flap and short gill rakers (Page and Burr 1991).

Systematic notes: *Lepomis macrochirus* forms a sister pair with *L. humilis* (Near *et al.* 2004, 2005). The bluegill is polytypic. Three subspecies are generally recognized, but the geographic ranges and diagnostics of all forms are not well defined (Hubbs and Allen 1943; Hubbs and Lagler 1958; Avise and Smith 1974, 1977; Felley 1980; Page and Burr 1991). Populations on the Florida peninsula, colloquially known as coppernose bluegill (Ross 2001), differ morphologically (broader lateral bars and red fins) and genetically from the nominate subspecies *L. m. macrochirus*. Intergradation between the two occurs from the Ochlockonee River (eastern Gulf Coast drainage) north along the Atlantic Slope drainages to South Carolina (Avise and Smith 1974, 1977; Felley 1980). The name applied to the Florida form is *L. m. mystacalis*. The name *L. m. purpurescens*, although traditionally applied to the Florida form (Hubbs and Allen 1943), is associated with a type locality in North Carolina and is a synonym of *L. m. macrochirus* (Gilbert 1998). The name *L. m. speciosus* is applied to populations in Texas and Mexico (Hubbs and Lagler 1958; Page and Burr 1991). *Lepomis m. macrochirus* occupies the remainder of the native range. A color variant, known locally as the "handpaint brim," occurs in the Apalachicola River valley in Florida (Felley and Smith 1978).

Importance to humans: Because of their fearlessness, inquisitiveness, color, and activity, bluegill are seen, recognized, and enjoyed by more of the fishing and nonfishing public than probably any other species of freshwater fish (Scott and Crossman 1973). To many, nearly any *Lepomis* encountered is dubbed a "bluegill." The bluegill probably accounts for more individual catches than any other gamefish in North America (Etnier and Starnes 1993), and for decades, the largemouth bass and bluegill have formed the core predator–prey species combination in sport fisheries management of warmwater ponds, lakes, and reservoirs (Bennett 1948; Swingle 1949). Historically, the species formed part of the commercial "sunfish" catch in natural lakes such as the Great Lakes and Reelfoot Lake, Tennessee (Schoffman 1945; Scott and Crossman 1973). The bluegill is a scrappy fighter that readily takes an array of small artificial flies, spinners, or natural baits (e.g., crickets, earthworms, or even dough balls). They attack the bait in groups, bite hard, and fight hard, creating a challenging catch for the experienced flyfisher, the cane pole enthusiast, or as a child's first catch. The species is an excellent-tasting table fish, the flesh being white and slightly sweet (Scott and Crossman 1973; Etnier and Starnes 1993; Ross 2001).

13.8.7 Lepomis marginatus *(Holbrook)*

13.8.7.1 Dollar sunfish

Characteristics: See generic account for general characteristics. Deep, compressed body, depth 0.5 of SL. Mouth small, terminal, oblique, supramaxilla small (>3 times and ≤4 times length of maxilla), upper jaw not extending posteriorly past anterior edge of eye. Wavy blue lines on cheek and opercle of adult. Opercular flap long, flexible, usually slanted upward, black in center, but often flecked with silver-green blotches, edged with white or pale green, lower and upper borders of equal width. Pectoral fin short and rounded, tip usually not reaching eye when laid forward across cheek. Short, thick, knoblike gill rakers, 9 to 10, longest about equal (adults) to two (young) times greatest width. Lateral line complete. Lateral scales, (34)37 to 40(44); rows above lateral line, 5 to 6; rows below lateral line, (12)13 to 14(15); cheek scale rows, 3 to

4(6); caudal peduncle scale rows, (18)19(21); pectoral rays, (11)12 to 13. Pharyngeal arches narrow with sharply pointed teeth. No teeth on endopterygoid, ectopterygoid, palatine, or glossohyal (tongue) bones (Bailey 1938; Barlow 1980; Etnier and Starnes 1993; Mabee 1993).

Size and age: Average 57 mm TL at age 1. Large individuals measure 95 mm TL and attain age 4+ or more (maximum 127 mm TL, age 6+) (Lee and Burr 1985; Page and Burr 1991; Winkelman 1993; Etnier and Starnes 1993). Mean male length is greater than that of same-age females (Winkelman 1993).

Coloration: Similar to longear and northern longear sunfish but lateral line is colored brick red. Breeding male bright red, marbled and spotted with blue-green, and often with large silver-green flecks accenting dark center of ear flap (Page and Burr 1991).

Native range: The dollar sunfish occurs in Atlantic and Gulf Slope drainages (mostly below the Fall Line) from the Tar River, North Carolina, to the Brazos River, Texas, and the Mississippi Embayment from western Kentucky and eastern Arkansas, south to the Gulf of Mexico (Page and Burr 1991). The species is most common in the southeastern United States, becoming increasingly uncommon in the western part of its range (Robison and Buchanan 1984; Loftus and Kushlan 1987; Page and Burr 1991; Wolfe and Prophet 1993; Snodgrass *et al.* 1996; Pflieger 1997; Marcy *et al.* 2005).

Habitat: The dollar sunfish inhabits sand- and mud-bottomed wetlands, oxbows, or other swamplike habitats as well as the brushy pools of lowland creeks and small to medium rivers (Page and Burr 1991). The species is most often associated with small, low-gradient headwater streams, side channels of streams, beaver ponds, and periodically isolated floodplain wetlands (Meffe and Sheldon 1988; Etnier and Starnes 1993; Paller 1994; Snodgrass *et al.* 1996; Snodgrass and Meffe 1998). The dollar sunfish is one of the most abundant, but smallest, species of *Lepomis* in the Florida Everglades, where it is almost always associated with dense vegetation and reaches peak numbers in sawgrass marshes and marsh prairies (Loftus and Kushlan 1987). Removal of aquatic vegetation by grass carp (*Ctenopharyngodon idella*) in a eutrophic Texas reservoir resulted in almost complete elimination of the dollar sunfish (Bettoli *et al.* 1993).

Food: The dollar sunfish is an opportunistic invertivore. The primary dietary items are midge larvae, microcrustaceans, terrestrial insects, snails, and oligochaetes (Chable 1947; McLane 1955; Lee and Burr 1985; Sheldon and Meffe 1993). Large amounts of detritus, filamentous algae, and terrestrial insects in stomachs indicate bottom-to-surface feeding (Etnier and Starnes 1993). Dollar sunfish leave stream channels to presumably forage on floodplains inundated during short-term spring flood events (Ross and Baker 1983).

Reproduction: Maturity is reached at age 1+ at a minimum size of about 60 mm SL (Lee and Burr 1985). Spawning is protracted, occurring from April to September in Florida (McLane 1955) and May to July or August in North and South Carolina (Lee and Burr 1985; Winkelman 1996; Marcy *et al.* 2005). In the Carolinas, peak spawning occurs from mid-May to late June or July (Lee and Burr 1985; Winkelman 1996). Males use caudal sweeping to remove silt and organic debris from a variety of substrates to form small, shallow depressions (30 cm diameter), usually <2 m from shore at depths of 10 to 50 cm (Winkelman 1996). Nests may be solitary (>1 m apart) or in dense colonies of 20 or more closely spaced nests (Lee and Burr 1985; Mackiewicz *et al.* 2002; Marcy *et al.* 2005). The agonistic courtship and other reproductive behaviors of guardian males are apparently typical of other *Lepomis*, but observations are not extensive or detailed (Lee and Burr 1985; Winkelman 1996). Genetic analyses indicate that males spawn on average with 2.5 females (range 1–7) in a given spawning event and that about 95% of offspring in nests are sired by the guardian male. One nest takeover and one instance of cuckoldry by a neighboring nesting male were detected in 23 nests examined, but no evidence of nest parasitism by nonparental males was detected by paternity analysis or gonadal examination (Mackiewicz *et al.* 2002). The entire cycle of egg and larval guarding is about 6 days (Winkelman 1996). Colonial spawning in a North Carolina pond was asynchronous, continuing long after eggs were present in the nest and resulting in some males simultaneously guarding eggs and two previous broods. Nests produced about 150 to 200 larvae, and larvae reached 10 mm TL after 1 month (Lee and Burr 1985). Depending on reproductive stage of the nest, guardian males differentially adjusted retreat times from the nest in response to avian predator models (aerial and wading). Males returned to the nest sooner when offspring were present than when nests were empty, indicating awareness of a threat to their survival but a willingness to accept greater risk to protect their current brood (Winkelman 1996).

Nest associates: Bluenose shiner, *Pteronotropis welaka* (Johnston and Knight 1999).

Freshwater mussel host: None known (but see Stern and Felder 1978).

Conservation status: The dollar sunfish is considered secure throughout most of its range, but is regarded within several states, particularly those on the periphery of the range, as vulnerable (Arkansas, Oklahoma, North Carolina) or critically imperiled (Kentucky) (NatureServe 2006). The species was likely much more widespread and abundant historically than it is now in those lowland areas subjected to stream channelization, wetland drainage, and intensive agricultural use (e.g., eastern Arkansas, western Kentucky, western Tennessee) (Robison and Buchanan 1984; Burr and Warren 1986; Etnier and Starnes 1993).

Similar species: Within the range of the dollar sunfish, any longear-like sunfish occurring in nonflowing, low-gradient, or swamplike habitats is likely a dollar sunfish, although longear sunfish and dollar sunfish are taken together, especially in streams draining the eastern Mississippi Embayment (Burr and Warren 1986; Page and Burr 1991; Etnier and Starnes 1993). The longear sunfish usually has 13 to 14 pectoral rays and 5 to 7 cheek scale rows. The northern longear sunfish does not co-occur with the dollar sunfish and has a red spot on the ear flap. The redbreast sunfish lacks blue spots on the sides and has rows of red-brown spots on the upper sides, a longer narrower ear flap that is black to the edge, and usually 14 pectoral rays (Barlow 1980; Page and Burr 1991).

Systematic notes: *Lepomis marginatus* is included in a clade with *L. peltastes* and *L. megalotis* (Near *et al*. 2004, 2005), but relationships among these species are unresolved. Interestingly, nuclear-encoded allozyme frequency data from a limited number of populations indicated that *L. marginatus* is genetically more similar to *L. megalotis breviceps* and *L. m. aquilensis* than to *L. m. megalotis* or *L. peltastes* (Jennings and Philipp 1992a). In contrast, phenetic analysis of 47 morphological and meristic characters indicated that *L. marginatus* (Louisiana and North Carolina samples) is most similar to its allopatric relative *L. peltastes* (Barlow 1980). Comparative studies across the range of *L. marginatus* are lacking, but polytypy is indicated from phenetic analyses of morphological characters (Barlow 1980), differences in opercular tab pigmentation (Page and Burr 1991; Etnier and Starnes 1993), and differences in breeding color patterns described by hobbyists (Wolff 2005).

Importance to humans: Although not reaching a size of interest to panfish anglers, the dollar sunfish, where it occurs commonly, is an ecological indicator of relatively undisturbed lowland and wetland ecosystems.

13.8.8 Lepomis megalotis *(Rafinesque)*

13.8.8.1 Longear sunfish

Characteristics: See generic account for general characteristics. Deep, compressed body, depth 0.43 to 0.45 of SL. Mouth moderately large, terminal oblique, supramaxilla small (>3 times and ≤4 times length of maxilla), upper jaw reaches posteriorly from beyond anterior of eye to just about center of eye. Wavy blue lines on cheek and opercle of adult. Opercular flap long, flexible (flared at end in large individuals), usually oriented horizontally (adult) or slanting upward (young), black in center with white edges, lower and upper edges of equal width, bordered above and below by blue line. Pectoral fin short and rounded, tip usually not reaching eye when laid forward across cheek. Short, thick, knoblike gill rakers, 12 to 14, longest about equal (adults) to twice (young) greatest width. Lateral line complete. Lateral scales, (31)36 to 48(50); rows above lateral line, (5)6 to 8(9); rows below lateral line, (11)14 to 15(19); cheek scale rows, (4)5 to 6(8); caudal peduncle scale rows, (16)18 to 23(25); pectoral rays, (11)13 to 14(15). Pharyngeal arches narrow with sharply pointed teeth. No teeth on endopterygoid, ectopterygoid, palatine, or glossohyal (tongue) bones (Bailey 1938; Barlow 1980; Trautman 1981; Mabee 1993; Boschung and Mayden 2004).

Size and age: Size at age 1 is highly variable among habitats and across latitudes, ranging from 21 to 114 mm TL (median 47 mm TL). Individuals rarely exceed 155 mm TL or 100 g, and few live beyond age 6+ (maximum about 240 mm TL, 227 g, and age 9+) (Bacon 1968; Carlander 1977; Page and Burr 1991; Etnier and Starnes 1993; Jennings and Philipp 1992c). World angling record, 0.79 kg, New Mexico (IGFA 2006). Parental males grow faster than females (Carlander 1977; Jennings and Philipp 1992c).

Coloration: Ear flap long, black in adult, edged in white, bordered above and below by blue lines. Numerous, wavy blue lines on sides of snout, cheek, and opercle. Young with olive back and side speckled with yellow flecks, often with chainlike bars on sides, white below. Adult dark red above, bright orange below, marbled and spotted with blue; clear to orange and blue, unspotted fins. Breeding males are among the most brilliantly colored North American fishes, with contrasting bright reddish orange and blue body, red eye, orange to red median fins, and blue-black pelvic fins (Page and Burr 1991). Nape with reddish stripe in upper Arkansas and Missouri River populations, and at least some populations in the upper White River, Missouri, lack the light border on the ear flap (Pflieger 1971; Barlow 1980; Goddard and Mathis 1997).

Native range: The longear sunfish is native to the Mississippi River Basin west of the Appalachian Mountains from Indiana west to eastern Illinois and south to the Gulf of Mexico and to Gulf Slope drainages from the Choctawhatchee River, Florida, west to the Rio Grande, Texas, southern New Mexico, and northeastern Mexico (Page and Burr 1991; Miller 2005). The species is generally common, and often the most abundant *Lepomis* in upland or clear streams throughout its range. The species has expanded its range in recent decades north and westward in the Missouri River, Missouri, as a likely result of clear water conditions imposed on that system by upstream reservoirs (Pflieger 1997). The longear sunfish has been introduced sparingly outside its native range and is established in the upper Ohio River basin (New and Kanawha, above the Falls, rivers), the Atlantic Slope (Potomac River drainage and Maryland Coastal Plain), upper Rio Grande (New Mexico), and perhaps, the Pacific Slope of Mexico (Rio Yaqui) (Fuller *et al.* 1999; Miller 2005).

Habitat: The longear sunfish inhabits rocky and sandy pools of headwaters, creeks, and small to medium rivers (Page and Burr 1991) and can thrive along shorelines of reservoirs (Bacon 1968; Gelwick and Matthews 1990; Bettoli *et al.* 1993; Etnier and Starnes 1993; Pflieger 1997). In some rivers, the longear sunfish can be the most abundant centrarchid (Gunning and Suttkus 1990). The species is tolerant of low DO (e.g., 100% survival at <1 ppm for 3 days) and high water temperatures (critical thermal maxima >34°C) (Matthews 1987; Smale and Rabeni 1995a,b; Beitinger *et al.* 2000). In streams, many individuals use restricted home activity areas (<100 m) over several seasons (or years) and displaced individuals can home over short distances apparently using olfactory cues (Gerking 1953; Gunning 1959, 1965; Gunning and Shoop 1963; Huck and Gunning 1967; Fentress *et al.* 2006). Even so, short (>200 m) interhabitat and long-distance (<15 km) exploratory movements are not uncommon, the species can quickly repopulate drought affected streams or defaunated stream reaches, and large individuals in streams appear to desert home activity areas in fall, presumably to migrate to wintering areas (Funk 1957; Boyer 1969; Berra and Gunning 1972; Matthews 1987; Lonzarich *et al.* 1998, 2000; Warren and Pardew 1998; Smithson and Johnston 1999; Fentress *et al.* 2006). A spring branch along Jacks Fork River, Missouri, serves as a winter thermal refuge for large numbers of longear sunfish. Lowest use of the spring branch occurs from April to October when adjacent river temperatures exceed those of the spring branch (13.5°C) and highest use occurs during cold periods when the spring waters exceed river temperatures. During cold, but not warm, periods, biomass and size of individuals in the spring branch are larger than those of individuals remaining in the river. Mark-recapture results suggest the existence of two populations of longear sunfish, one consisting of permanent spring branch residents and another that migrates to the spring branch during cold periods and back to the river during warm periods (Peterson and Rabeni 1996).

Food: The longear sunfish is an opportunistic invertivore. Adults are principally benthic predators on larval midges, mayflies, and caddisflies but also consume a variety of other aquatic insects and terrestrial invertebrates as well as small fish, fish eggs (e.g., *Micropterus* and *Pomoxis*), isopods, amphipods, crayfishes, and gastropods (Minckley 1963; Applegate *et al.* 1967; Boyer 1969; Cooner and Bayne 1982; Angermeier 1985; Shoup and Hill 1997). Young longear sunfish (<50 TL) transition from an initial diet predominated by microcrustaceans and some aquatic insect larvae to increasing use of aquatic and terrestrial insects (50–100 mm TL). Surface insects can contribute substantially to the diet of the largest longear sunfish (>100 TL) (Applegate *et al.* 1967; Cooner and Bayne 1982; Angermeier 1985), and the species is highly efficient at capturing zooplankton or floating prey in flowing water (up to 18 cm/s; Schaefer *et al.* 1999). Feeding rates are initially high in spring, are relatively stable over much of the summer, and decline in October, a pattern attributed to decreasing availability of aquatic insect prey (Angermeier 1985; Kwak *et al.* 1992). Over a series of diel studies (May to October), feeding peaks occurred near dusk and dawn but some feeding occurred continuously over 24-hour periods (Bowles and Short 1988; Kwak *et al.* 1992). In late winter, stream-dwelling individuals collected well before dawn had apparently electively consumed nocturnally drifting amphipods (Bowles and Short 1988). In a laboratory tank, longear sunfish cleaned external fish parasites from a live, heavily infested flathead catfish, suggesting that, like the bluegill, they may serve in nature as commensal cleaners of other fishes (Spall 1970).

Reproduction: Maturity is reached at age 1+ to 3+ at a minimum size of about 60 mm TL in females and 100 to 140 mm TL for guardian males (Boyer 1969; Carlander 1977; Jennings and Philipp 1992c), but sneaker male phenotypes can mature at age 1+ and 40 to 85 mm TL (Jennings and Philipp 1992c). Spawning is protracted and may include up to six relatively discrete nesting periods occurring from late May to mid-July or August at intervals of about 12 days (Huck and Gunning 1967; Boyer and Vogele 1971; Carlander 1977; Jennings and Philipp 1994). Observations in Missouri reservoirs indicate that spawning temperatures range from 22 to 28°C with nest abandonment occurring if water temperature abruptly decreased below or increased above this range (Witt and Marzolf 1954; Boyer and Vogele 1971), but in a Louisiana stream, nesting occurred at 29 to 31°C (Huck and Gunning 1967). Flood events (and presumably lowered water temperatures) delayed initiation of spawning, resulted in high nest abandonment, and decreased brood survival in an Illinois stream (Jennings and Philipp 1994). Vitellogenesis was suppressed in wild females exposed to unbleached Kraft mill effluents (paper mills) in the Pearl River, Mississippi, and the number of spawning cycles appeared to be lower than in unexposed females. No reproductive suppression effects were detected in males (Fentress *et al.* 2006). Males excavate nests by caudal sweeping. The shallow, roughly circular depressional nests range from about 33 to 89 cm diameter, are 3 to 7 cm deep, and are usually placed in areas free of brush or vegetation over sand or gravel at water depths of 20 to 150 cm (up to 3.4 m in reservoirs, Huck and Gunning 1967; Boyer and Vogele 1971; Mueller 1980). Within a population, nesting males tend to be larger than non-nesting males, even though the smaller non-nesting males are mature. Of males nesting, successful males are on average larger than unsuccessful males, suggesting that females prefer large males (Jennings and Philipp 1992b). If male size is equal, females prefer males with longer ear tabs (Goddard and Mathis 1997). Nests are most often colonial (e.g., 2 to 45 nests, <1 m apart), presumably affording subordinate guardian males more access to females, but solitary nests are not uncommon (Boyer and Vogele 1971; Jennings and Philipp 1992b). In some populations, solitary males tend to be larger than colonial males, and their nesting success is equivalent to that of colonial males (Jennings and Philipp 1992b), but in other populations solitary males tend to be smaller than colonial nesters (Boyer 1969). Spawning events in colonies are asynchronous with spawning females entering nests for 1 or 2 days or even as long as 1 week, resulting in some males simultaneously guarding eggs and larvae (Boyer and Vogele 1971; Jennings and Philipp 1994). Nest-guarding males produce gruntlike sounds as part of courtship (Gerald 1971); other reported courtship, spawning, and brood defense and care behaviors appear typical for the genus (e.g., rim circling, lateral threat displays, paired circling). After spawning, the male may alternate egg fanning with caudal sweeping to mix eggs in the substrate, and both males and females engage in frequent substrate biting during nest defense and before circling, respectively (Witt and Marzolf 1954; Huck and Gunning 1967; Boyer 1969; Boyer and Vogele 1971). During a spawning event, a female spawns with a given male about 20 times for 20 to 29 minutes, depositing 7 to 20 eggs with each dip into the nest; several females may ultimately spawn in a single nest. Females may spawn with one male and then enter another nest to spawn with another male (Boyer and Vogele 1971). Spawning pairs are frequently interrupted by sneaker male morphs, neighboring nesting males, or males of other *Lepomis* spp. attempting to steal fertilizations (Huck and Gunning 1967; Boyer and Vogele 1971; Jennings and Philipp 2002). Although patchily distributed, sneaker male morphs are documented in Illinois stream populations (Jennings and Philipp 1992c, 2002). Observations of two ostensible females spawning simultaneously with a male (Boyer 1969; Boyer and Vogele 1971) suggest that the sneaker tactic may be more widespread than is currently documented. Ovaries of mature females contain several distinct sizes and developmental stages of ova, and the mature ovarian eggs are apparently large for *Lepomis*, averaging 1.55 to 2.00 mm diameter (Boyer 1969; Yeager 1981). Fecundity increases with female size, but relationships are apparently unquantified. Estimates of numbers of spawned ova for three size classes of females in two Missouri reservoirs were 1417 to 3600 eggs (≤100 mm TL), 3440 to 4136 eggs (101–129 mm TL), and 4213 eggs (≥130 mm TL) (Boyer 1969). Most of the adhesive, fertilized eggs in a colony hatch in about a week, but time to hatching may extend for 12 days or more at 25°C (Huck and Gunning 1967; Boyer 1969). Numbers of eggs in 12 nests ranged from 608 to 2756, and numbers of larvae in six successful nests averaged 465 (range 3 to 1132). Larvae at hatching are of 5.0 to 5.2 mm TL, and advanced larvae in a nest ranged from 5.8 to 7.5 mm TL (mean = 6.9 mm TL) (Boyer 1969; Boyer and Vogele 1971; Yeager 1981). Successful males guard and vigorously defend the eggs and larvae for up to 9 days, depending on developmental rate of offspring (Jennings and Philipp 1994). While nest guarding, males feed opportunistically, consuming large numbers of longear sunfish eggs, high volumes of detritus, and nearby aquatic insects (Boyer 1969; Boyer and Vogele 1971). Larval swim-up and dispersal occur at 7.3 to 7.6 mm TL about 6 to 8 days after hatching (22–25°C, presumably) (Huck and Gunning 1967; Boyer and Vogele 1971; Yeager 1981). Larval fin development is apparently more rapid than in most other *Lepomis* (Taber 1969; Yeager 1981). After leaving the nest, fry from several nests initially merge to form large schools in dense cover but later separate into small groups or as single individuals (Boyer and Vogele 1971).

Nest associates: Redfin shiner, *L. umbratilis* (Snelson and Pflieger 1975).

Freshwater mussel host: Confirmed host to *A. suborbiculata, L. siliquoidea, M. nervosa, P. grandis, Strophitus subvexus*, and *V. nebulosa* (Penn 1939; Haag and Warren 1997; Howells 1997; O'Dee and Watters 2000). Putative host to *L. recta, S. undulatus, T. lividus, U. imbecillis*, and *Villosa contricta* (unpublished sources in OSUDM 2006).

Conservation status: The longear sunfish as currently conceived appears secure throughout its range (Warren *et al.* 2000; NatureServe 2006, but latter includes *L. peltastes*), but the status of evolutionarily significant units or undescribed taxa in northern Mexico is of concern (Miller 2005). Because of evidence of polytypy, a comprehensive characterization of variability across the geographic range is needed to clarify the conservation status of the Rio Grande and other suspected forms of the longear sunfish.

Similar species: See accounts on dollar sunfish and northern longear sunfish. The redbreast sunfish lacks blue spots on the sides and has rows of red-brown spots on upper side and a longer, narrower ear flap that is black to its edge. The pumpkinseed has bold spots on the second dorsal fin and long, pointed pectoral fins, and a stiff posterior edge on the gill cover (Page and Burr 1991).

Systematic notes: *Lepomis megalotis* is included in a clade with *L. peltastes* and *L. marginatus* (Near *et al.* 2004, 2005), but relationships among these species are unresolved (see accounts on these species). *L. megalotis* is polytypic. In a morphological analysis of variation that did not include breeding colors (Barlow 1980), four subspecies (not including *L. peltastes*) were delimited: *L. m. megalotis, L. m. breviceps, L. m. aquilensis* (Rio Grande to Brazos River, Texas), and an undescribed subspecies (Little River, Oklahoma and southwestern Arkansas). *L. m. megalotis* was differentiated into four races: eastern Gulf race, Ozark race, Central and Interior Lowland race, and Coosa River race. The subspecies *L. m. breviceps* was differentiated into two races: Upper Arkansas and Missouri basin race and east Texas race. Differences in breeding colors and opercular tab orientation occur in middle Missouri River and upper White River populations (Pflieger 1971). Analysis of nuclear-encoded allozyme loci confirmed genetic distinctiveness of the southwestern populations (*L. m. aquilensis* and *L. m. breviceps*) from *L. m. megalotis*, suggested intergradation or retained ancestral polymorphisms in the Ozark Highlands between *L.m. breviceps* and *L. m. megalotis*, and indicated considerable divergence within *L. m. megalotis* (Jennings and Philipp 1992a). A fifth subspecies, *L. m. occidentalis*, from the Rio Grande system (Bailey 1938), could not be differentiated meristically or morphometrically from *L. m. aquilensis* (Barlow 1980), but striking differences in breeding colors in Rio Grande populations suggest that additional taxa are present (Miller 2005).

Importance to humans: Despite its relatively small size, the longear sunfish is of considerable importance in stream fisheries where it can comprise a large proportion of the creel (up to 37% by weight) (e.g., Mississippi, Missouri, Tennessee). It vigorously attacks a variety of live baits, small spinners, dry flies, and popping bugs, and is a scrappy fighter when taken on light tackle. Larger specimens also provide a tasty morsel for the table (Etnier and Starnes 1993; Pflieger 1997; Ross 2001). In reservoirs, young-of-the-year longear sunfish are an important forage fish for largemouth bass, particularly for 5 to 20 cm bass during summer and fall (Applegate *et al.* 1967).

13.8.9 Lepomis microlophus *(Günther)*

13.8.9.1 Redear sunfish

Characteristics: See generic account for general characteristics. Body moderately deep, compressed, depth 0.42 to 0.50 of SL. Mouth moderate, terminal, oblique, supramaxilla small (>3 times and ≤4 times length of maxilla), upper jaw extends almost to, or to, anterior edge of eye. No wavy blue or dark lines on cheek and opercle; soft dorsal, anal, and caudal fins not marked with dark brown wavy lines or orange spots. Opercular flap, short, moderately flexible with black center bordered above and below in white or light slate and posteriorly by prominent red (male) to orange (female) crescent (often pale in young). Pectoral fin long and pointed, tip extending far past eye when laid across cheek. Gill rakers short, 9 to 11, longest about two times greatest width. Lateral line complete. Lateral scales, 34 to 47; rows above lateral line, 6 to

8; rows below lateral line, 13 to 16; cheek scale rows, 3 to 6; caudal peduncle scale rows, 16 to 22; pectoral rays, 13 to 16. Pharyngeal arches extremely broad, heavy with large rounded, molariform teeth. Teeth present or absent on palatine. No teeth on endopterygoid, ectopterygoid, or glossohyal (tongue) bones (Bailey 1938; Trautman 1981; Mabee 1993).

Size and age: Size at age 1 is highly variable among habitats and across latitudes, varying from about 30 to 185 mm TL (median 86.5 mm TL). Large individuals measure 200 to 250 mm TL, weigh about 200 to 300 g, and can attain age 6+ to 9+ (maximum 269 mm TL, age 11+) (Schoffman 1939; Carlander 1977; Trautman 1981; Page and Burr 1991; Sammons *et al.* 2006). World angling record, 2.48 kg, South Carolina (IGFA 2006).

Coloration: Bright red or orange spot on light colored edge of ear flap (best developed on large adult). Light gold-green above; dusky gray spots (adults) or bars (young) on sides; white to yellow below. Fins mostly clear, some dark mottling in second dorsal fin of adult. Breeding male brassy gold with dusky pelvic fins (Page and Burr 1991).

Native range: The redear sunfish is native to the Atlantic and Gulf Slope drainages from about the Savannah River, South Carolina, to the Nueces River, Texas, and ranges in the Mississippi River basin north from the Gulf to southern Indiana and Illinois (Page and Burr 1991). The species is now widely introduced and established in the eastern and western United States, usually in reservoirs, including the Colorado River basin and Pacific Slope drainages (Page and Burr 1991; Fuller *et al.* 1999). After tbe introduction of the nonnative redear sunfish, native pumpkinseed in a southern Michigan lake experienced a 56% decline in abundance (Huckins *et al.* 2000).

Habitat: The redear sunfish inhabits ponds, oxbows, swamps, lakes, and reservoirs and the sluggish pools and backwaters of small to medium size rivers (Page and Burr 1991). The species is much more abundant in clear, vegetated backwaters than in turbid, hypoxic backwaters or flowing main channels of streams and rivers (Beecher *et al.* 1977; Pflieger 1997; Rutherford *et al.* 2001; Miranda and Lucas 2004). Redear sunfish, known from salinities up to 20 ppt, acclimate physiologically more quickly to salinity changes (1 hour, ≤8 ppt) relative to congeners and *Micropterus* (12 hours), and are among the most euryhaline centrarchids. This physiological adaptation may allow redear sunfish to withstand the rapidly changing salinities of tidal rivers (Peterson 1988).

Food: The redear sunfish is highly specialized for crushing hard-bodied prey such as snails, small bivalves, and ostracods, earning it the appellation of "shellcracker" among anglers. Similar to the pumpkinseed, the species possesses heavy pharyngeal jaw bones that are equipped with molariform teeth, enlarged muscles, and specialized neuromuscular adaptations (Lauder 1983a,b, 1986; Wainwright and Lauder 1992; Huckins 1997). In contrast to the pumpkinseed, the redear sunfish nses the crushing apparatus on all prey types as evidenced by muscular activity patterns, but the pumpkinseed displays the crushing pattern only when feeding on snails (Lauder 1983a,b). Redear sunfish also appear better adapted for hard-bodied prey than pumpkinseed. At a given size, redear sunfish have more robust pharyngeal structures and possess about twice the shell crushing capacity of pumpkinseed, and hence, can consume larger (and harder) snails than similar-sized pumpkinseed (Huckins 1997). In laboratory choice experiments, redear sunfish discriminated against thick-shelled snail species and chose thin-shelled snail species (Stein *et al.* 1984). Young redear sunfish undergo a dramatic and rapid shift in diet from soft-bodied invertebrates to high numbers of snails as they grow from 25 to 75 mm TL. As principally benthic feeders, redear sunfish are certainly not limited to feeding on snails but also consume large numbers of larval dipterans and burrowing mayflies, amphipods, larval odonates, and a variety of other invertebrates (McCormick 1940; Chable 1947; Wilhur 1969; Desselle *et al.* 1978; Huckins 1997; VanderKooy *et al.* 2000). Feeding occurs frequently and apparently at random throughout the day (Wilbur 1969).

Reproduction: Maturity is reached at age 0+ or 2+ in females at 100 to 164 mm TL (Schoffman 1939; Wilbur 1969; Carlander 1977; Adams and Kilambi 1979). Spawning in Florida begins in late February or early March as water temperatures reach 21°C, and continues for 6 to 7 months and may involve up to five synchronous spawning peaks (Wilbur 1969). Over the reproductive season, spawning may cease for periods of 1 to 3 weeks. Nests are most abundant at water temperatures of 23.8 to 26.7°C, but nesting may continue up to 32.2°C (Clugston 1966). In less southerly latitudes, spawning occurs from about May to July or August (Adams and Kilambi 1979). Males excavate nests by caudal sweeping, the nests are colonial (<1 m apart), and colonies often contain nests of congeners (Childers 1967). Nests may be placed in shallow water (<0.5 m) (Clugston 1966), although the redear sunfish frequently nests in somewhat deeper water than most *Lepomis* (1 to >2 m, Wilbur 1969). Nests are 25 to 61 cm in diameter and 5 to 10 cm deep and constructed in hottoms of sand, gravel, or mud (Wilbur 1969). Nest-guarding males produce popping sounds (presumably with the jaw and pharyngeal bones) that are directed at the sides and head of females during courtship (Gerald 1971; see account on *L. gibbosus*). Little else is apparently known about nest-building, spawning, or nest-guarding behaviors. In ponds, female bluegills, the males of which have completely black opercular flaps, interhred with redear sunfish males when their red, white, and black opercular flaps were removed, but females did not interbreed when redear male flaps were intact (Childers 1967). Mature ovarian eggs range from 0.60 to 1.30 mm diameter (Adams and Kilambi 1979) and water-hardened, fertilized eggs from 1.3 to 1.6 mm diameter (Meyer 1970). Fecundity increases with female size. The relationships between potential batch fecundity (Y) and total length (X) are described by the functions, $\ln_{10} Y = 5.95424 + 0.01967X$ and $\log Y = 263.75 + 1.7109 \log X$ (formulas from Adams and Kilambi (1979), $n = 15$, $R^2 = 0.90$, and from Wilbur (1969), based on means from eight length classes, 82 females, $R^2 = 0.88$, respectively). At 182 mm TL, a female can potentially produce 13,824 to 17,812 mature eggs in a single batch (range: 7513 to 12,943 eggs at 151 mm TL to 23,316 to 25,437 eggs at 213 mm TL, respectively). Eggs hatch in 50.3 hours at 23.8°C, 26.6 to 28.1 hours at 28.5°C; newly hatched larvae are 3.3 to 3.8 mm TL and reach swim-up in about 3 days at 4.78 to 5.80 mm TL (Childers 1967; Meyer 1970; Yeager 1981).

Nest associates: None known.

Freshwater mussel host: Confirmed host to *A. neislerii* (O'Brien and Williams 2002). Putative host to *L. teres* (unpublished sources in OSUDM 2006).

Conservation status: The redear sunfish is apparently secure throughout its range (but see section on systematic notes), except for peripheral populations in Illinois that are considered imperiled (NatureServe 2006). Historically, abundant, widely distributed redear populations occurred in lakes on the large Yazoo River alluvial floodplain in Mississippi. Now, the species has practically disappeared from these lentic habitats apparently in response to increased turbidity from agricultural activities (Miranda and Lucas 2004).

Similar species: The pumpkinseed has bold spots on the second dorsal fin, wavy blue lines on the cheek and opercle, and a stiff rear edge on the gill cover. The longear, northern longear, and dollar sunfishes have short, rounded pectoral fins, wavy blue lines on the cheek and opercle, and a long ear flap (Page and Burr 1991).

Systematic notes: *Lepomis microlophus* is sister to the species pair, *L. punctatus* and *L. miniatus* (Near *et al.* 2004). On the basis of shared behavioral and morphological specializations for mollusk-crushing, *L. gibbosus* was proposed previously as sister to *L. microlophus* (Bailey 1938; Mabee 1993). Two subspecies of the redear sunfish, *L. m. microlophus* and an undescribed subspecies, are recognized based on essentially nonoverlapping scale counts, pectoral fin length differences, and opercular flap coloration (Bailey 1938). The range of the two subspecies is not entirely clear from the original work (Bailey 1938), but the undescribed subspecies occurs in the Mississippi River Valley westward to the San Marcos River, Texas, and perhaps east in the middle Gulf Slope to southern Mississippi, and *L. m. microlophus* occurs in eastern Gulf and Atlantic Slope drainages of Alabama, Georgia, and Florida (Page and Burr 1991). Phylogeographic analyses using mtDNA haplotypes along the southeastern seaboard of the United States revealed genetic discontinuities that were largely congruent with boundaries identified by morphological differentiation (Bailey 1938; Bermingham and Avise 1986). The widespread practice of moving and stocking redear sunfish in the southern United States may have obscured the boundaries of the two forms, but clarification of their current status awaits thorough genetic and morphological comparisons.

Importance to humans: The redear sunfish, the "shellcracker" to many anglers, is a popular sport fish that is often stocked in combination with largemouth hass and bluegill in ponds and reservoirs. Because of its bottom-feeding habits, the species fills a niche little used by other *Lepomis*, and redear sunfish do not tend to overcrowd and stunt in ponds as do bluegill. The fast growth rate, large size, and mild flavor combine to make them a highly desirahle pan fish. The redear sunfish is often one of the primary fish in sunfish sport fisheries and can account for a substantial portion (up to 66%) of the sunfish harvest by weight in southern lakes and reservoirs (Schramm *et al.* 1985; Crawford and Allen 2006; Sammons *et al.* 2006). From 1976 to 1981, 36 to 332 thousand kilograms of redear sunfish were harvested annually by commercial fishing operations in Lake Okeechobee, Florida, constituting about 8% of the total commercial catch over this period (Schramm *et al.* 1985). The species is less likely to be taken on artificial lures than bluegill but readily takes worms and other natural baits fished near the bottom. Nesting males are taken in large number by anglers (Wilbur 1969; Etnier and Starnes 1993; Ross 2001). Nonnative snails and bivalves (e.g., Asian clam, *Corbicula fluminea*) are often exploited as food by redear sunfish (Moyle 2002), and the species is used effectively as a native biological control for snails that serve as intermediate hosts to detrimental parasites of pond-raised channel catfish (Ledford and Kelly 2006).

13.8.10 Lepomis miniatus *Jordan*

13.8.10.1 Redspotted sunfish

Characteristics: See generic account for general characteristics. Body deep, compressed, depth 0.45 to 0.50 of SL. Mouth moderate, terminal, oblique, supramaxilla small (>3 times and ≤4 times length of maxilla), upper jaw extending just to or slightly beyond anterior margin of eye. Iridescent turquoise crescent outlining ventral curvature of red or dark eye. No wavy blue lines on head. Two to three diffuse bars often radiate posterior to the eye, and small spots on head, if present, most prominent on the preopercle and subopercle, often diffuse or coalesce to form dark, short streaks. Body in breeding males with horizontal rows of red-orange spots (one per scale) below the lateral line; black specks rarely present. Opercular flap, stiff, short with black center narrowly bordered above and below by pale white, posterior edge with narrow pale white border, often lacking; dorsal edge of flap red-orange in breeding males. Pectoral fin short and rounded, tip usually not reaching eye when laid forward across cheek. Gill rakers moderate to long, 8 to 11, longest about two to four times greatest width. Lateral line complete. Lateral scales, (33)35 to 41(42); rows above lateral line, (4)6 to 7(8); rows below lateral line, (11)12 to 14(15); cheek scale rows 4 to 6(7); breast scale rows (11)12 to 15(18); caudal peduncle scale rows, (15)18 to 21(22); pectoral rays (12)13 to 14(15). Pharyngeal arches narrow with sharply pointed teeth. Teeth present or absent on palatine bones. No teeth on endopterygoid, ectopterygoid, or glossohyal (tongue) bones (Bailey 1938; Warren 1992; Mabee 1993).

Size and age: Typically reach 30 to 80 mm TL at age 1. Large individuals measure 133 to 153 mm TL and attain age 4+ (maximum about 164 mm TL) (Carlander 1977; Warren 1992; Roberts *et al.* 2004).

Coloration: Ear flap, short, black with narrow dorsal and ventral white edges (suffused in orange in breeding male). Sides with red-orange, horizontal rows of spots, best developed at level of pectoral fin in breeding males. Ventral curvature of dark or red eye outlined with iridescent turquoise crescent (in life), a characteristic unique to *L. miniatus* and *L. punctatus*. Dark olive above; pale to yellow on breast and anterior belly. Breeding males with red-orange on breast, anterior belly, and pale circular to quadrate blotch above ear flap; dusky to dark pelvic fins; distal one-half to one-third of soft dorsal, soft anal, and caudal fins suffused with red-orange to reddish brown and narrowly edged in silvery, creamy, pinkish, or white margins (Page and Burr 1991; Warren 1992).

Native range: The redspotted sunfish is native to the Illinois River, Illinois (relictual population, Burr and Page 1986), and south in the Mississippi River Valley to the Gulf Slope. On the Gulf Slope, the species occurs from the Nueces River, Texas, to, and inclusive of, the Mobile Basin, Alabama (Warren 1992). The introduced or native status of individuals from the Devils River (Rio Grande drainage), Texas, is equivocal (Warren 1990). Populations in drainages of the Florida Panhandle (inclusive of drainages from the Perdido to Apalachicola rivers), upper Coosa River tributaries (Alabama River drainage), and Lookout Creek (Tennessee River drainage) form a zone of contact in which individuals cannot be clearly identified morphologically as redspotted or spotted sunfishes (Warren 1992).

Habitat: The redspotted sunfish inhabits well-vegetated ponds, lakes, and slow-flowing pools of creeks and small to medium rivers, being most abundant in natural floodplain lakes (Page and Burr 1991), where it tolerates periodic hypoxic conditions (<1 mg/l DO, Killgore and Hoover 2001). Removal of aquatic vegetation by grass carp (*C. idella*) in a eutrophic Texas reservoir resulted in almost complete elimination of redspotted sunfish (Bettoli *et al.* 1993). The species also occurs in coastal habitats of low salinity (usually <4 ppt), where it can be one of the most abundant centrarchids (Desselle *et al.* 1978; Peterson and Ross 1991). Length–weight relationships were not different between two populations experiencing annual salinities ranging from 1 to 10 ppt (average = 4) and 0 to 4 ppt annually (average = 0.91), respectively, suggesting that oligohaline conditions produce little or no metabolic consequences for the species (Peterson 1991; Peterson and Ross 1991).

Food: The redspotted sunfish is an invertivore that forages primarily in submerged aquatic vegetation and bottom sediments but can also exploit surface prey. The most comprehensive food studies were conducted in low-salinity coastal environments with marine faunal elements (Lake Pontchartrain, Louisiana, and Davis Bayou, Mississippi). In oligohaline habitats, adult fish (>60 mm SL) feed on mud crabs, isopods, amphipods, and a variety of aquatic insects (dipteran larvae, caddisfly larvae, terrestrial insects) (Desselle *et al.* 1978). In a freshwater stream, food consisted primarily of adult and larval insects (Robison and Buchanan 1984). Small fish (≤60 mm SL) feed initially on copepods, midges, cladocera, mysid shrimp, and mayfly larvae, gradually transitioning to higher consumption of larger crustaceans and insects (Desselle *et al.* 1978; VanderKooy *et al.* 2000).

Reproduction: The reproductive biology of the redspotted sunfish is not well studied but is presumably similar to that of its sister species, the spotted sunfish, *L. punctatus*. Spawning is protracted. Nesting activity was observed from early April to August in Texas, May to early August in Illinois, and in July in Missouri (Forbes and Richardson 1920; Robison and Buchanan 1984; Pflieger 1997; Roberts *et al.* 2004). When transferred from experimental ponds in Illinois to indoor aquaria, males and females spawned in artificial nests in August (Roberts *et al.* 2004). In Missouri streams, nests are placed in a few centimeters of water among stems of water willow over a bottom of sand and gravel. Some males nest solitarily, but two or more males often build adjacent or even confluent nests (Pflieger 1997). Eggs hatch in about 36 hours at 26°C, and larvae reach swim-up about 4 to 5 days after hatching (Roberts *et al.* 2004).

Nest associates: None known.

Freshwater mussel host: None known.

Conservation status: The redspotted sunfish is secure throughout its range (Warren *et al.* 2000), but peripheral northern populations are considered vulnerable (Indiana, Tennessee) or imperiled (Illinois and Kentucky) (NatureServe 2006) because of losses of populations and lowland habitats (Smith 1979; Burr and Warren 1986; Burr *et al.* 1988).

Similar species: The spotted sunfish lacks rows of red or yellow spots on the sides and has discrete black specks, often numerous, on head and body. The bantam sunfish lacks rows of red or yellow spots on the sides, lacks a brassy-red patch above the ear flap, has a black spot in the posterior second dorsal fin (in juveniles), and has an interrupted or incomplete lateral line. The longear, northern longear, dollar, and redbreast sunfishes have wavy blue lines on the cheek, longer ear flaps, and short, thick to knobby gill rakers (Page and Burr 1991).

Systematic notes: *Lepomis miniatus* is the sister species of *L. punctatus* (Near *et al.* 2004, 2005). Although long recognized as distinct (Jordan 1877), *L. miniatus* was considered a subspecies of *L. punctatus* throughout most of the twentieth century (Bailey 1938; Bailey *et al.* 1954). Morphological (meristics, pigmentation, breeding color) and genetic (nuclear-encoded allozyme loci and mitochondrial and nuclear DNA) data support recognition of *L. miniatus* as a distinct species (Warren 1989, 1992; Bermingham and Avise 1986; Near *et al.* 2004, 2005). Populations from the Perdido River, Alabama, east to the Apalachicola river and those in upper Coosa River tributaries (Alabama River drainage) and Lookout Creek (Tennessee River drainage) show scale counts that are intermediate morphologically between the two species. Genetic distance analyses from nuclear-encoded allozyme loci, pigmentation patterns, and breeding colors suggest closer affinity of these contact zone populations to *L. punctatus*, but population sampling was limited for the allozyme analyses (Warren 1989, 1992). Whether these contact zone populations represent past or ongoing introgression and retained ancestral polymorphisms or a distinct evolutionary lineage awaits further analyses.

Importance to humans: The redspotted sunfish, although providing sport, is generally too small to be a significant pan fish. Even so, the species contributes to the bream creel, particularly for bank anglers using cane poles in wetlands, backwaters, and small, lowland streams. The species is most often taken using worms or crickets but may also be taken at the surface on popping bugs. The flesh is firm and mild (Etnier and Starnes 1993).

13.8.11 Lepomis peltastes *Cope*

13.8.11.1 Northern longear sunfish

Characteristics: See generic account for general characteristics. Deep, compressed body, depth 0.42 to 0.53 of SL. Mouth moderately large, oblique, jaws subequal, supramaxilla small (>3 times and ≤4 times length of maxilla), upper jaw extends to about center of eye, always beyond anterior edge of eye. Wavy blue lines on cheek and opercle of adult. Opercular flap long, flexible, pointing upward with black center edged above and below in yellow or white, posterior edge often with red spot; lower border usually wider than upper. Pectoral fin short and rounded, tip usually not reaching eye when laid forward across cheek. Short, thick, knoblike gill rakers, 12 to 14, longest about equal (adults) to two (young) times greatest width. Lateral line often incomplete or interrupted behind posterior base of dorsal fin. Lateral scales, (31)35 to 37(41); rows above lateral line, 5 to 6(7); rows below lateral line, (11)12 to 13(14); cheek scale rows, 4 to 6(7); caudal peduncle scale rows, (14)17 to 19(21); pectoral rays, (11)12 to 13(14). Pharyngeal arches narrow with pointed teeth. No teeth on endopterygoid, ectopterygoid, palatine, or glossohyal (tongue) bones (Bailey 1938; Gruchy and Scott 1966; Scott and Crossman 1973; Barlow 1980; Trautman 1981; Becker 1983; Mabee 1993; Bailey *et al.* 2004).

Size and age: Typically reach 30 to 48 mm TL at age 1. Large individuals measure 96 to 102 mm TL and attain age 4+ (maximum about 150 mm TL, 9+ years) (Hubbs and Cooper 1935; Scott and Crossman 1973; Becker 1983; Jennings and Philipp 1992c).

Coloration: Similar to *L. megalotis*, but black ear flap edged in yellow (or red), the lower edge often wider than upper (Barlow 1980; Trautman 1981; Page and Burr 1991).

Native range: The northern longear sunfish occurs in the St. Lawrence-Great Lakes drainages from southern Quebec, western New York, northwestern Pennsylvania, northern Ohio and Indiana, the Lower Peninsula of Michigan, eastern Wisconsin, northern Minnesota, and southern Ontario (including Hudson Bay system). The species occurs, or occurred historically, in scattered localities in the Mississippi River basin in northwestern Wisconsin, northeastern Illinois, Minnesota, and Iowa (Smith 1979; Trautman 1981; Becker 1983; Underhill 1986; Jennings and Philipp 1992a; Bailey *et al.* 2004).

Habitat: The northern longear sunfish inhabits pools of clear, shallow streams and moderate sized rivers as well as ponds and lakes (Scott and Crossman 1973; Trautman 1981; Becker 1983). The species avoids densely vegetated littoral habitats and sediment-laden, turbid habitats. In southern Michigan, northern longear sunfish occurred in greatest abundance in lakes containing shoreline benches of exposed marl sediments and was rare or absent in lakes with organic-laden sediments or dense aquatic vegetation covering shallow (<2 m) littoral zones, regardless of sediment type (Laughlin and Werner 1980). Within a lake, most large individuals (>75 mm TL) occur in sparsely to moderately vegetated habitats, and small individuals (<38 mm TL) concentrate in the most densely vegetated areas. The species decreased dramatically in distribution and abundance in tributaries and shallows of Lake Erie as those habitats received increased sediment loads in the twentieth century (Trautman 1981).

Food: The northern longear sunfish is a benthic invertivore. In a summer diet study, lake-dwelling adults (>75 mm TL) primarily consumed dragonfly and mayfly larvae and amphipods. The species uses a sit-and-wait foraging strategy, remaining still and close to the bottom, apparently keying in on the slight movements of cryptic or burrowing prey (Laughlin and Werner 1980).

Reproduction: Maturity is reached at age 2+ at 45 to 75 mm SL, occasional large individuals mature at age 1+ (Hubbs and Cooper 1935; Jennings and Philipp 1992c). In experimental ponds, both males and females matured at age 1+, but sneaker male phenotypes (e.g., drab coloration, large gonads) matured at a smaller size (40–60 mm TL) than parental males (60 mm TL) (Jennings and Philipp 1992c). Spawning is protracted (late May to August) with peaks in July (Hubbs and Cooper 1935; Keenleyside 1972; Dupuis and Keenleyside 1988). Nest building and spawning occur as water temperatures exceed 20°C, but lengthening photoperiod in spring is most strongly associated with initiation of nest-building behaviors in males. Out-of-season nest building occurred under experimental conditions of long photoperiod (16 hours) and warm water temperatures (25°C). Under a long photoperiod and cold temperature (11–13°C), some males began but did not complete nests; no males built nests under a short photoperiod (8 hours) regardless of temperature (Smith 1970). Most nest-guarding males are 73 to 111 mm TL (Keenleyside 1971; Dupuis and Keenleyside 1988). Males excavate small saucer-shaped nests (average 33 cm diameter) with caudal sweeping over areas of mixed sand and gravel or where gravel substrate is covered by silt, which is swept away by the males before spawning. Nests are usually close to shore in shallow water (10–60 cm) with little current and are often near aquatic vegetation or overhanging shrubs (Bietz 1981; Dupuis and Keenleyside 1988). Although a few males nest solitarily (<4%), most males excavate their nest in close proximity to other nesting males to form dense colonial aggregations of rim-to-rim hexagonally shaped nests (<20 to 100+ nests) (Keenleyside 1972; Bietz 1981; Dupuis and Keenleyside 1988). Colonies are formed when new males (peripheral males) excavate nests around those of early nesting males (central males). Colonies are definitely social aggregations because formation occurs in the absence of habitat limitation (Bietz 1981). Breeding is synchronous in colonies, and over the long breeding season five or six distinct spawning periods occur. Males spawning later in the breeding season obtain larger numbers of larvae (average 750) than those breeding earlier (<300) (Dupuis and Keenleyside 1988). Likewise, males spawning first during a given breeding period obtain more larvae than those nesting on the second or third day. Agonistic, courtship, spawning, and nest defense behaviors are well documented (e.g., opercular spreads, tail-beating, bites, nest circling, dipping), and form a large part of the foundation for our knowledge of reproductive biology and behavior in the genus (Keenleyside 1967, 1971, 1972; Steele and Keenleyside 1971). Nest preparation is accomplished in <24 hours, but females arrive on the spawning grounds before all nests are completed. Females are usually courted by several males (e.g., courtship circles with shivers and vibrations) but may also spawn in a male's nest without any overt courtship (Keenleyside 1967; Steele and Keenleyside 1971). Females often spawn with several males during a spawning event and often enter a nest to eat eggs before being chased away by the guardian male (Keenleyside 1972; Dupuis and Keenleyside 1988). Females can visually distinguish conspecific from other *Lepomis* males (Steele and Keenleyside 1971), suggesting an ability to chose mates. Likewise, nesting males can visually distinguish conspecific from other *Lepomis* females, but non-nesting males show weaker discrimination between conspecific and other *Lepomis* females (Keenleyside 1971). Within colonies, females spawn preferentially with males nesting early within a spawning period and those with centrally located nests. Females also appear to choose larger over smaller males. Solitary nesting males are larger than and as successful as colonial males in obtaining eggs and larvae (Dupuis and Keenleyside 1988). These patterns suggest that nesting colonies arise so that males unlikely to attract females (i.e. smaller, peripheral guardian males) increase their exposure to and probability of spawning with females attracted to centrally located males (Bietz 1981; Dupuis and Keenleyside 1988). Up to five or six small sneaker males, which can be numerous around some nests (50+ individuals), frequently interrupt a spawning pair en masse in an attempt to steal fertilizations (Keenleyside 1972; Dupuis and Keenleyside 1988). The frequency of intrusions into nests by neighboring guardian males is also high (average, one per minute) (Keenleyside 1972). Spawning occurs over a 2- to 3-day period, males guard and fan the eggs, which hatch in 2 to 3 days, and continue guarding the larvae until they reach swim-up and disperse about 4 to 6 days after hatching. Males may then abandon the nest or begin cleaning and preparing it for another spawning (Dupuis and Keenleyside 1988).

Nest associates: Redfin shiner, *L. umbratilis* (Noltie and Smith 1988).

Freshwater mussel host: None known (see longear sunfish, *Lepomis megalotis*).

Conservation status: The northern longear sunfish is apparently secure throughout the center of its native range (e.g., Lower Peninsula of Michigan). The species occurs primarily in scattered and isolated populations in the eastern and western parts of its range, where population declines and losses are documented (e.g., Ohio, Trautman 1981; Wisconsin, Becker 1983). The species is rare and considered critically imperiled in New York and Pennsylvania, imperiled in Quebec and Wisconsin, and vulnerable in Ontario (Scott and Crossman 1973; Becker 1983; Smith 1985; NatureServe 2006).

Similar species: See accounts on longear sunfish and dollar sunfish.

Systematic notes: *Lepomis peltastes*, only recently elevated to species status (Bailey *et al.* 2004), is in a clade with *L. megalotis*, and *L. marginatus*, but relationships among the taxa are unresolved (see accounts on *L. megalotis* and *L. marginatus*; Jennings and Philipp 1992a; Near *et al.* 2004, 2005). *L. peltastes* was long considered a dwarf form of *L. megalotis* (e.g., Hubbs and Cooper 1935) even though there is apparently no evidence of intergradation between the two (Smith 1979; Trautman 1981). In a phenetic cluster analysis using 47 meristic and morphological variables, populations of *L. peltastes* formed a basal cluster that was highly distinctive from all populations of *L. megalotis* (Barlow 1980). Interestingly, specimens from the Muskingum River (Ohio River basin) clustered with *L. peltastes*, suggesting that the southern geographic limits of the species are incompletely known. Frequency data from nuclear-encoded allozyme loci did not separate *L. peltastes* from *L. m. megalotis* (Jennings and Philipp 1992c). Nevertheless, the two clearly differ in morphological and life history traits (i.e. growth, maturity, reproductive investment) (Barlow 1980; Jennings and Philipp 1992a,b,c; Bailey *et al.* 2004).

Importance to humans: The northern longear sunfish does not reach a size of interest to anglers; however, the breeding males are among the most stunningly beautiful of all North American freshwater fish. Although extremely aggressive toward conspecifics, it is otherwise easy to keep and breed in the laboratory or hobbyist's aquaria (e.g., Keenleyside 1967;

Bietz 1981). Studies of the northern longear sunfish increased our understanding of the social, agonistic, and reproductive behaviors and ecology for the genus and highlighted the value of freshwater fishes, especially centrarchids, as models for sociobiological research (e.g., Keenleyside 1967, 1971,1972; Smith 1970; Steele and Keenleyside 1971; Bietz 1981; Dupuis and Keenleyside 1988; Jennings and Philipp 1992a,c).

13.8.12 Lepomis punctatus *(Valenciennes)*

13.8.12.1 Spotted sunfish

Characteristics: See generic account for general characteristics. Body deep, compressed, depth 0.45 to 0.50 of SL. Mouth moderate, terminal, oblique, supramaxilla small (>3 times and ≤ 4 times length of maxilla), upper jaw extending just to or slightly beyond anterior margin of eye. Iridescent turquoise colored crescent outlining ventral curvature of eye. No wavy blue or dark lines on head and no horizontal rows of red-orange spots on sides. Discrete, small dark spots form irregular horizontal rows on sides of body and dorsum, especially prevalent on lower sides. Cheek and opercle often speckled with black spots. Opercular flap, stiff, short with black center outlined above and below by narrow white edges (yellow-orange to pinkish-orange in breeding males), posterior margin edged with narrow pale white border, often lacking. Pectoral fin short and rounded, tip usually not reaching eye when laid forward across cheek. Gill rakers moderate to long, 8 to 11, longest about three to five times greatest width. Lateral line complete. Lateral scales, (37)38 to 44(47); rows above lateral line, (6)7 to 8(9); rows below lateral line, (12)13 to 15(16); cheek scale rows, (4)5 to 7(8); breast scale rows, (14)15 to 18(20); caudal peduncle scale rows, (7)8 to 10; pectoral rays, (12)13 to 14(15). Pharyngeal arches narrow with sharply pointed teeth. Teeth present or absent on palatine bones. No teeth on endopterygoid, ectopterygoid, or glossohyal (tongue) bones (Bailey 1938; Warren 1992; Etnier and Starnes 1993; Mabee 1993).

Size and age: Typically reach about 30 to 50 mm TL or more at age 1. Large individuals measure 165 to 180 mm TL, weigh 105 to 140 g (maximum 207 mm TL, 376 g), and presumably attain age 4+ to 5+, but estimates of size at age and maximum longevity are problematic (Caldwell *et al*. 1957; Page and Burr 1991; Warren 1992; Marcy *et al*. 2005).

Coloration: Ear flap, short, black with white to yellow edges. Head and sides with many discrete, black specks, most prominent on lower sides. Ventral curvature of dark or red eye outlined with iridescent turquoise crescent, a characteristic unique to *L. punctatus* and *L. miniatus*. Dark olive above; pale to butterscotch yellow on breast and anterior belly; clear to dusky fins; very narrow silvery, creamy, pinkish, or white margins on median fins. Darkly pigmented breeding males with a pale patch above ear flap and dusky to dark pelvic fins (Page and Burr 1991; Warren 1992).

Native range: The spotted sunfish is native to the Coastal Plain from the Cape Fear River, North Carolina, south in Atlantic Slope drainages to the Everglades and north and west in East Gulf Slope drainages to the Ocklockonee River, Georgia and Florida. From the Perdido River, Alabama, east to the Apalachicola River Basin the spotted sunfish forms a contact zone with the redspotted sunfish (see account on *L. miniatus*).

Habitat: The spotted sunfish inhabits pools of small to medium rivers and heavily vegetated ponds, lakes, and swamps (Page and Burr 1991). In streams, the species is most often associated with instream wood, stumps, or undercut banks in slow current and soft substrates (Meffe and Sheldon 1988; Marcy *et al*. 2005). On the North Carolina Coastal Plain, the spotted sunfish is the most common and widely distributed centrarchid in first- to fourth-order streams and is also common, especially the young-of-the-year, in beaver ponds (Snodgrass and Meffe 1999). In Florida, the species occurs in abundance in densely vegetated springs, spring runs, and spring-fed rivers (Hubbs and Allen 1943; Carr 1946; Swift *et al*. 1977). Spotted sunfish are also the most abundant and ubiquitous centrarchid in the Everglades region, where the species accounts for the second highest biomass of all carnivorous fishes within wet-prairie habitats (Clugston 1966; Loftus and Kushlan 1987; Turner *et al*. 1999). In large pool habitats, adults are often observed in open water during the day, moving inshore at night; juveniles tend to stay in dense vegetation (Hubbs and Allen 1943; Loftus and Kushlan 1987). The species can penetrate waters up to at least 12.5 ppt and is a relatively common inhabitant of coastal tidewater and oligohaline habitats (Kilby 1955; Loftus and Kushlan 1987). Genetic analyses of Everglades populations suggest that the species is adept at immigrating en masse into seasonally dry habitats once the habitats are reinundated (McElroy *et al*. 2003).

Food: The spotted sunfish is an opportunistic invertivore, picking invertebrates from the surface, aquatic plants, the bottom, and the stream drift. In North Carolina streams, adults (>45 mm SL) feed primarily on terrestrial invertebrates, midge larvae, mayflies, and decapods and occasionally on snails, bivalves, and fish (Sheldon and Meffe 1993; Marcy *et al.* 2005). Smaller individuals consume more midge larvae, along with aquatic and terrestrial insects, and a few water mites, amphipods, and copepods. Limited stomach analyses in a Florida spring indicated concentrated foraging in aquatic plant beds and associated sediments. Midge larvae, caddisfly larvae, freshwater shrimp, and isopods dominated the diet (Caldwell *et al.* 1957). Stomachs often contain substantial volumes of plant and algal matter (Caldwell *et al.* 1957; Marcy *et al.* 2005), presumably ingested incidentally while gleaning invertebrates from aquatic plants.

Reproduction: Maturity is reached at age 1+ and a size of about 50 to 55 mm TL (Carr 1946; Caldwell *et al.* 1957). Most actively spawning females are 76 to 101 mm TL (maximum >127 mm TL), and nest-guarding males are 84 to 178 mm TL (Carr 1946; DeWoody *et al.* 2000a). In North Carolina, spawning occurs from late May to late July at water temperatures of 24 to 27°C (Marcy *et al.* 2005). The spawning season is prolonged in the Florida Everglades with nesting occurring from March to November (temperatures from 17.7–33.3°C), but lengthy pauses in spawning occur during this period, presumably in association with water temperatures exceeding 30°C (Clugston 1966; Loftus and Kushlan 1987). In near-constant temperature spring-fed streams in Florida (22.8°C), some individuals appear to be spawning year round because ripe males, ripe females, and juveniles are taken in every month of the year. However, gonads of the majority of individuals in these environments are well developed between March and August (Kilby 1955; Caldwell *et al.* 1957). Males use caudal sweeping over sand or sand mixed with pebbles and snail shells to excavate relatively small nests (15–61 cm diameter, 25–50 cm deep). Nests are placed in shallow water (10–38 cm) near or against the bank (Carr 1946; Clugston 1966; Marcy *et al.* 2005) and tend to be solitary in small streams, but males may also aggregate their nests into groups of two or more (Hubbs and Allen 1943; Carr 1946; DeWoody *et al.* 2000a). During courtship, males frequently flash their solid black ventral fins at nearby females and rush toward females, ultimately driving spawning-ready females to the nest. Males mate with multiple females and continue to accept eggs for up to 3 days after spawning begins. During this period males frequently orient head down with the snout thrust into the gravel in an apparent inspection of the eggs. In a North Carolina stream population, conservative estimates from genetic maternity analyses indicated that a male spawns with an average of four females (range, one to six) (DeWoody *et al.* 2000a). Evidence was suggestive, though not conclusive, that larger males received eggs from more females than smaller males. In the same population, paternity analyses revealed the occurrence of nest takeovers by guardian males, and the presence in low frequencies (5–15%) of precociously mature sneaker males (DeWoody *et al.* 2000a). Cuckoldry, however, was estimated at only 1.3% of all offspring examined. Other spawning, nest-guarding, and associated behaviors are typical of the genus (Carr 1946). Female size and fecundity relationships are apparently not quantified. Water-hardened, fertilized eggs are 1.4 to 1.8 mm in diameter, adhesive (often adhering to fine roots along the shoreline side of the nest), demersal, and dark brownish olive to pale transparent amber in color (Carr 1946; Marcy *et al.* 2005). The male constantly fans the eggs until they hatch (2.0–2.2 days; presumed temperature of 20–24°C; hatchling length, 4 mm TL). About 10 days after hatching, swim-up larvae (6.5–7.0 mm TL) begin leaving the nest over a 2-day period and briefly form loose schools in the surrounding area before dispersing (Carr 1946). Anecdotal accounts suggest that guardian males are among the most pugnacious and tenacious defenders of eggs and larvae among centrarchids (Hubbs and Allen 1943; Carr 1946; Clugston 1966).

Nest associates: Golden shiner, *N. crysoleucas* (Carr 1946).

Freshwater mussel host: None known.

Conservation status: The spotted sunfish is currently stable (Warren *et al.* 2000) but is considered vulnerable in North Carolina, the northern periphery of its range (NatureServe 2006).

Similar species: See account on redspotted sunfish. The redspotted sunfish lacks distinct black specks on head and body (Page and Burr 1991; Warren 1992).

Systematic notes: *Lepomis punctatus* is the sister species of *L. miniatus* (Near *et al.* 2004, 2005) (see account on *L. miniatus*).

Importance to humans: Most spotted sunfish are caught incidentally by bluegill and redear sunfish anglers, but the spotted sunfish is a consistent part of the panfish creel in many Florida waters (e.g., Suwannee River). Although of relatively small size, the species aggressively attacks live baits, such as crickets, mealworms, or Catalpa worms, or small popping bugs. When taken on ultralight gear, the species puts up a scrappy fight, and as table fare, the flesh is excellent (FFWCC 2006).

13.8.13 Lepomis symmetricus *Forbes*

13.8.13.1 Bantam sunfish

Characteristics: See generic account for general characteristics. Body deep, compressed, depth 0.48 to 0.53 of SL. Mouth moderately large, supramaxilla small (>3 times and ≤4 times length of maxilla), upper jaw extending beyond anterior edge of eye. Black spot posterior of soft dorsal fin in young, diminishing with growth, absent in large adults. Lacks the bright coloration of other *Lepomis*. Opercular flap short, stiff, and black with pale posterior margin. Very long slender gill rakers, 12 to 15, longest about six to eight times greatest width. Pectoral fin short and rounded, tip usually not reaching eye when laid forward across cheek. Lateral line usually incomplete (1–18 scales unpored) or interrupted (up to 6 times). Lateral scales, (30)32 to 36(40); rows above lateral line, 5 to 7; rows below lateral line, 12 to 14; cheek scale rows, (4)5(6); caudal peduncle scale rows, (17)18 to 21(22); pectoral rays, (11)12 to 13. Pharyngeal arches narrow with small, blunt subconical teeth. Teeth on palatine bones. No teeth on endopterygoid, ectopterygoid, or glossohyal (tongue) bones (Bailey 1938; Burr 1977; Page and Burr 1991; Etnier and Starnes 1993; Mabee 1993).

Size and age: Typically reach 34 to 46 mm SL at age 1. Large individuals measure 55 to 64 mm SL, and few live beyond age 2+ (maximum, 93 mm TL, age 3+) (Burr 1977; Page and Burr 1991). The bantam sunfish is the smallest and has the shortest maximum lifespan of any *Lepomis*. Growth differences between males and females are minimal (Burr 1977).

Coloration: Ear flap, short, black with light edge. Lacks bright coloration of other *Lepomis*. Dusky green above and on sides; yellow flecks and scattered small dark brown spots (adult) or chainlike bars (young) on sides; yellow-brown below. Anal and dorsal fins, red in young, clear to dusky in adults (Burr 1977; Page and Burr 1991)

Native range: The bantam sunfish is native to drainages of the Mississippi Embayment and lower Ohio River Valley from Illinois and western Indiana to the Gulf of Mexico and the Gulf Coastal Plain from Bay St. Louis, Mississippi, to the Colorado River, Texas (Page and Burr 1991). A post-Pleistocene relict population in the Illinois River is now extirpated as are populations in the lower Wabash River (Illinois and Indiana) (Burr 1977; Burr and Page 1986, 1991; NatureServe 2006). The species is most common in Louisiana and east Texas and a few scattered, relatively undisturbed remnant floodplain lakes and wetland systems in the lower Mississippi River alluvial valley (e.g., Wolf and Horseshoe Lakes, Illinois; Mingo Swamp, Missouri; Murphys Pond, Kentucky; Reelfoot Lake, Tennessee) (Burr 1977; Burr and Warren 1986; Burr *et al.* 1988; Etnier and Starnes 1993; Pflieger 1997).

Habitat: The bantam sunfish is a phytophilic species occurring almost exclusively in oxbow lakes, floodplain ponds, overflow swamps, and sloughs that are characterized by standing timber, submerged logs, and dense beds of aquatic plants (Burr 1977; Page and Burr 1991). Substantial populations can also occur in large, shallow eutrophic reservoirs (Bettoli *et al.* 1993) and freshwater coastal marshes (Gelwick *et al.* 2001). The species occupies the shallow (15–120 cm) heavily vegetated margins of lentic habitats over mud, detritus, and decayed plant material (Burr 1977) and is tolerant of hypoxic conditions associated with dense aquatic plants beds (<1 mg/l DO, Gelwick *et al.* 2001; Killgore and Hoover 2001). Removal of aquatic vegetation in Lake Conroe, Texas, by nonnative grass carp (*C. idella*) resulted in a population collapse of the bantam sunfish (Bettoli *et al.* 1993). The species can apparently migrate across flooded lowlands during major flood events (Mississippi River flood, 1993), resulting in establishment of founder populations in formerly unoccupied habitats (Burr *et al.* 1996).

Food: The bantam sunfish is an opportunistic invertivore. Adult (>40 mm SL) diets are predominated by odonate larvae, amphipods, hemipterans, dipteran larvae, mayflies, and gastropods. The diet of juvenile bantam sunfish (<30 mm TL) is similar to that of the adult, but includes higher consumption (to 40 mm TL) of microcrustaceans and midge larvae and lacks gastropods. Terrestrial or surface-dwelling insects (hemipterans) in stomachs indicate that some surface feeding occurs. Seasonally consumed foods include heavy use of gastropods in winter and spring and hemipterans in summer (Burr 1977).

Reproduction: The female bantam sunfish matures at 34 to 45 mm SL at an age of 11 to 13 months; mature males are at least of age 1+ and ≥40 mm SL (Burr 1977). In captivity with optimal feeding, sexual maturity is reached in as little as 5 to 7 months (Wetzel 2007). Few other *Lepomis* (e.g., green and orangespotted sunfishes) consistently mature at such small sizes. The bantam sunfish also differs from congeners, particularly sympatric species, in its earlier and shorter spawning period, relatively small mature ova, and low batch fecundity. Males and females in breeding condition are present from mid-April to early June with peak breeding condition occurring in May at water temperatures of 18 to 22°C. In aquaria, males used caudal sweeping and the anal fin to excavate nests (70–120 mm diameter, 2 cm deep) over both sand and gravel, but in natural settings nests are excavated over fibrous root material in dense aquatic vegetation or over mud and leaf litter (Robison 1975; Zeman and Burr 2004; Wetzel 2007). Nests are closely spaced (about 40 cm apart), and as territorial boundaries are established, neighboring males are intensely aggressive (e.g., biting attacks) and display frequently (e.g., opercle flaring) toward neighboring nesting males (Wetzel 2007). In aquaria, if females are unresponsive to courtship, the nest-guarding male will nip, nudge, badger, opercle flare, and continuously circle the female, ultimately killing her (Burr 1977; Zeman and Burr 2004; Wetzel 2007). Receptive females rotate and flash the ventral surface toward the male, and in response, he repeatedly rushes to her and back to the nest until she follows. Once over the nest, the pair circles and spawns for about 30 minutes, at which time the male chases the female away. After spawning, males may engage in brief bouts of caudal sweeping and begin interspersing fanning of the eggs with aggressive displays and actions toward neighboring males. Spawning in aquaria occurred at about dawn at water temperatures of 22 to 26°C. The mature ova are translucent orange in color and range from 0.6 to 0.9 mm in diameter; fertilized eggs are adhesive (Burr 1977; Zeman and Burr 2004; Wetzel 2007). Fecundity increases with female size. The relationship between potential batch fecundity (Y) and adjusted body weight (X, total weight minus ovaries and viscera) is described by the linear function, $Y = -50.94 + 210.7X$ ($n = 14$, $R^2 = 0.67$; for SL, $\log_{10} Y = -2.785 + 3.383 \log_{10} X$, $R^2 = 0.44$; formulas from Burr 1977). At 2.44 g (ca. 42 mm SL), a female can potentially produce 463 mature eggs in a single batch (range: 248 eggs at 1.42 g, ca. 34 mm SL, to 1544 eggs at 7.57 g, ca. 52 mm SL). The male defends eggs and larvae for about 6 to 7 days. Eggs hatch in 26 to 36 hours at 22 to 26°C and reach swim-up about 5 days post hatch. Males defend the eggs and young with aggression noticeably increasing as the fry reach swim-up. Larvae begin leaving the nest by ascending in the water column and at dusk take refuge and feed in vegetation beds. Male defense of the young continues to be high until the larvae ascend into the vegetation (Zeman and Burr 2004; Wetzel 2007).

Nest associates: None known.

Freshwater mussel host: None known.

Conservation status: The bantam sunfish is likely much less widespread and abundant in the lowlands of the Mississippi Embayment and Gulf Coastal Plain than historically because of extensive channelization of streams and drainage of wetlands in the last century. Extirpations of northern populations in the Illinois and lower Wabash rivers exemplify effects of wetland habitat loss (Burr 1977; Zeman and Burr 2004). The species is considered critically imperiled in Indiana and Illinois, imperiled in Missouri and Oklahoma, and vulnerable in Texas and Arkansas (NatureServe 2006).

Similar species: Other *Lepomis* lack the dark spot at the rear of the second dorsal fin (diminishing with growth, absent in large adults) (except the bluegill and green sunfish). The green sunfish is more elongate, has a larger mouth, and has yellow-orange edges on its fins. The bluegill is more compressed, has a longer pectoral fin, and has a dark edge on its ear flap (Page and Burr 1991).

Systematic notes: *Lepomis symmetricus* forms a sister pair with *L. cyanellus* (Near *et al*. 2004, 2005). Interestingly, the sister pair comprises the smallest and second largest *Lepomis* and their ranges are sympatric. In a comprehensive study of morphological variation (Burr 1977), *L. symmetricus* showed surprisingly little variability, particularly given its distribution in isolated patches over a large geographic area. Variation in average counts showed a north–south clinal pattern. Populations in the Wabash River drainage were most aberrant, averaging higher scale and lower fin-ray counts.

Importance to humans: The bantam sunfish does not reach a size of interest to anglers. Ecologically, the presence and abundance of the species within its native range is a decided indicator of functioning, relatively intact wetland ecosystems.

13.9 *Micropterus* Lacépède

The genus *Micropterus*, collectively referred to as the black basses, is a monophyletic clade of eight species and is sister to the genus *Lepomis* (Near *et al.* 2004, 2005). The natural range of extant species encompasses most of eastern North America east of the Rocky Mountains, reaching northward to the Great Lakes, St. Lawrence River, and Hudson Bay drainages of Canada and eastward and southward in the Mississippi River basin, Atlantic Slope, and Gulf of Mexico drainages west to the Rio Grande and Rio Sota la Marina in Mexico (Robbins and MacCrimmon 1974; Page and Burr 1991; Miller 2005). A large fossil species, *Micropterus* †*relictus* Cavender and Smith, is estimated to have weighed over 5.5 kg and is known from Late Pliocene-Early Pleistocene deposits in Lake Chapala, Jalisco, Mexico, a location south of the native range of all other fossil or extant centrarchids (Smith *et al.* 1975; Miller and Smith 1986).

The smallmouth bass, largemouth bass, Florida bass, and to a lesser extent, the spotted bass form a quadtuplet of the most sought-after and valued freshwater sport fishes in North America. Other *Micropterus* are gaining sport fishing acclaim and popularity as unique, range-restricted fishes associated with beautiful, natural stream settings (e.g., Guadalupe bass, Shoal bass, Suwannee bass). No recreational fishery likely exceeds in economic scale the fishery targeting black basses (Ridgway and Philipp 2002). Of all anglers who fished in freshwater in 2001 (excluding the Great Lakes), 38% sought one or more species of black bass (Leonard 2005). The black bass recreational fishery ranked first among freshwater species in the number of anglers (10.7 million) and time spent fishing (nearly 160 million days). In the Great Lakes, black bass are second only to perch in the numbers of anglers (589,000 anglers) and time spent fishing (6.4 million days). Estimated direct expenditures (e.g., travel, lodging, equipment) associated with black bass fishing (excluding the Great Lakes) exceeded $10.1 billion (US) in 2001, and generated additional tens of billions of dollars more in indirect economic output and taxes (USFWS 2002; ASA 2005).

The reproductive behavior and biology of *Micropterus* are typical for the family in many ways but depart in others. The existence of extended parental care (see next paragraph), alternating mating systems (see account on *Micropterus dolomieu*), and biparental care (see account on *Micropterus salmoides*) distinguish the genus from other centrarchids. Unlike their sister genus *Lepomis*, *Micropterus* do not develop bright breeding colors, and obvious sexual dimorphism of any kind is minimal. During spawning, differential darkening or intensification of pigment patterns occurs in breeding males and females (Carr 1942; Breder and Rosen 1966; Heidinger 1975; Miller 1975; Trautman 1981; Williams and Burgess 1999). As in *Lepomis*, changes in pigment pattern in the female likely function as submissive signals to the male. *Micropterus* males are solitary nesters, usually establishing well-spaced territories and using caudal sweeping and other fin movements to excavate a typical, depressional centrarchid nest. Nests are most often constructed at the base of or near simple cover (Carr 1942; Neves 1975; Vogele 1975a, 1981; Winemiller and Taylor 1982; Wiegmann *et al.* 1992; Hunt and Annett 2002; Hunt *et al.* 2002). Nest-site fidelity in *Micropterus* is apparently high. Males may use nesting areas year after year with individual males often returning to within a few meters of their previous year's nest site or reusing the same nest in subsequent years (Carr 1942; Vogele 1975a; Ridgway *et al.* 1991a, 2002; Rejwan *et al.* 1997, 1999; Hunt *et al.* 2002; Ridgway *et al.* 2002; Waters and Noble 2004). In courtship, *Micropterus* males use leading or guiding courtship behaviors to attract females to the nest, often leaving the nest to approach, but not charge, the ripe female (Carr 1942; Ridgway *et al.* 1989).

In contrast to all other centrarchids, *Micropterus* males stay with their brood well after the swim-up stage and continue to guard free-swimming swarms of young, termed fry balls, until the young reach sizes of about 25 to 30 mm TL (e.g., Kramer and Smith 1962; Miller 1975; Vogele 1975a; Elliott 1976; Brown and Colgan 1985a; Friesen and Ridgway 2000). Large *Micropterus* males tenaciously guard their eggs, yolk-sac fry, free-swimming fry, and juveniles (Hubbs and Bailey 1938; Ridgway 1988; Wiegmann *et al.* 1992; Wiegmann and Baylis 1995; Steinhart *et al.* 2005). For example, males excluded from their nests by exclosures stayed nearby for 11 days and immediately began guarding the young on removal of the nest exclosures (Neves 1975). Although poorly documented in some species (e.g., Guadalupe and Shoal basses), the total period of parental care for successful males (spawning through fry dispersal) can last for 2 to 7 or more weeks (Hubbs and Bailey 1938; Kramer and Smith 1962; Pflieger 1966a; Miller 1975; Vogele 1975a; Cooke *et al.* 2006) but is highly variable even within a population in a single spawning season and among years (e.g., 19 to 45 days; Ridgway and Friesen 1992). Variability is largely a function of changes in water temperature, and hence larval developmental rate, but also involves interactive effects of the time of nesting (early versus late), size of male, and energy depletion in males. Large mature males tend to nest earlier at lower water temperatures and invest longer periods in parental care (through swim-up) than do small mature males (Ridgway and Friesen 1992).

The *Micropterus* male must patrol larger and larger areas as the fry balls forage increasing distances away from the nest (Ridgway 1988; Scott *et al*. 1997). Fry balls of *Micropterus* from single broods contain from several hundred to over ten thousand individuals (Kramer and Smith 1962; Friesen and Ridgway 2000). Individual broods often merge to form even larger groups of intermingled multiple broods of one or more black bass species, aggregations that cover extensive areas, and are under constant protection by one or more males (Carr 1942; Kramer and Smith 1962; Allan and Romero 1975; Vogele 1975a). Free-swimming juveniles of largemouth bass and perhaps other black basses are less oriented toward the nest than smallmouth bass; the juveniles leave the area of the nest and become increasingly mobile, feeding constantly during daylight hours and seeking cover at night (Carr 1942; Kramer and Smith 1962; Elliott 1976; Brown 1984, 1985; Brown and Colgan 1984). The increasing mobility of the roaming juveniles places high diurnal energy demands on the guardian males (Cooke *et al*. 2002a).

Generic characteristics: Elongate, slightly compressed body, depth usually <0.28 of TL. Dusky to black blotch at rear of gill cover (no long opercular flap). Dark, diagonal lines radiating from snout and back of eye to edge of opercle. Clear to olive-yellow fins; dusky spots on median fins. Mouth large, extending at least to below center of eye (in adults), supramaxilla large, well developed (≤ 2 times length of maxilla). Opercle with two flat projections, lower longer than upper. Emarginate caudal fin. Dorsal fin moderately to deeply emarginate, spiny portion continuous with to almost separate from soft-rayed portion. Long dorsal fin, usually 10 spines (9–10), 12 to 15 rays, usually 22 to 25 total; and short anal fin, 3 spines, 10 to 11 rays, 13 to 15 total. Dorsal fin base about two times longer than anal fin base. Pectoral fin rounded, rays 13 to 18. Preopercle margin entire. Gill rakers moderate in length, 5 to 11. Ctenoid scales. Lateral line complete; lateral line scales, ≥ 55. Vertebrae, usually 32(30–33) (14 or 15 + 17 or 18). Branchiostegal rays, 6. Pyloric caeca single or branched. Teeth present on palatine (villiform) and ectopterygoid. Teeth absent on endopterygoid and present or absent on glossohyal (tongue) bones (Bailey 1938; Hubbs and Bailey 1940, 1942; Bailey and Hubbs 1949; Bryan 1969; Page and Burr 1991; Mabee 1993; Williams and Burgess 1999).

Similar species: Species of *Micropterus* have three anal fin spines that separate them from all other centrarchids except *Lepomis* and *Enneacanthus*. *Micropterus* have emarginate caudal fins (versus rounded in *Enneacanthus*) and elongate, slightly compressed bodies with ≥ 55 lateral scales (versus deep, compressed body and <55 lateral line scales in *Enneacanthus* and *Lepomis*).

13.9.1 Micropterus cataractae *Williams and Burgess*

13.9.1.1 Shoal bass

Characteristics: See generic account for general characteristics. Elongate, slightly compressed body, depth 0.20 to 0.26 of TL, increasing with size. Mouth large, terminal, lower jaw slightly projecting, upper jaw reaches to posterior edge of eye in adult. Outline of spinous dorsal fin curved. Juncture of soft and spiny dorsal fins slightly emarginate, broadly connected. Shortest dorsal spine at emargination of fin, usually >0.6 times length of longest spine. Dorsal soft rays, usually 12, 10 to 13; anal soft rays, usually 10, 9 to 11. Gill rakers, usually 7, 6 to 9. Lateral scales, (65)72 to 77(81); rows above lateral line 8 to 9(12); rows below lateral line, (15)17 to 20(24); cheek scale rows, (11)13 to 15(18); caudal peduncle scale rows, (27)30 to 33(35); pectoral rays, (14)16 to 17. Small splintlike scales on interradial membranes at anal and second dorsal fin bases (>60 mm SL). Pyloric caeca, single, rarely branched, usually 12, 8 to 14. Tooth patch absent (a few teeth rarely present) on glossohyal (tongue) bone (Wright 1967; Williams and Burgess 1999; Kassler *et al*. 2002).

Size and age: Typically reach 60 to 109 mm TL (average, 66–96 mm) at age 1 (Parsons and Crittenden 1959; Wright 1967; Hurst 1969). Young-of-the-year stocked in ponds in June at 21 to 24 mm TL reached 142 to 169 mm TL by December (Smitherman and Ramsey 1972). Large individuals reach 380 to 450 mm TL, weigh 0.8 to 1.1 kg, and attain age 6+ to 8+ (maximum about 523 mm TL and 10+ years) (Parsons and Crittenden 1959; Wright 1967; Hurst 1969; Smitherman and Ramsey 1972; Page and Burr 1991; Gilbert 1992a; Williams and Burgess 1999). World angling record, 3.99 kg, Florida (IGFA 2006).

Coloration: Body with 10 to 15 midlateral and 6 to 8 dorsolateral, dark vertically elongate blotches, becoming gradually more quadrate posteriorly. Interspaces between midlateral blotches about equal to width of individual blotches, and supralateral blotches extend into interspaces between lateral blotches (may be obscured by dark dorsum). The vertically elongate blotches form a distinctive "tiger stripe" pattern. Large square to rectangular basicaudal blotch is usually present. Dusky to dark spots on ventrolateral scales frequently coalesce to form wavy lines. Iris typically bright red. Ground coloration above and on sides of head and body olive green to dark olive to black; body white to cream colored below (Williams and Burgess 1999).

Native range: The shoal bass is native to the Apalachicola and Chipola rivers in western Florida, the Chattahoochee River in eastern Alabama and western Georgia, and the Flint River in southwestern Georgia (Page and Burr 1991; Williams and Burgess 1999). In the 1970s, the species was introduced intentionally by state fisheries personnel into the Ocmulgee River (Altamaha River drainage), Georgia, where it is now established along 88 km of the main channel and adjacent tributaries (Williams and Burgess 1999).

Habitat: The shoal bass, as the name implies, is a frequent inhabitant of shoal areas of rivers and large streams (Williams and Burgess 1999). Although individuals of all sizes occur in both pools and shoals, as a percentage of the *Micropterus* assemblage, shoal bass are better represented in shoals. In the Chipola River, Florida, the ratio of age-0 and adult shoal bass to largemouth bass was greater in shoals than in pools (Wheeler and Allen 2003), results consistent witb observations elsewhere (Wright 1967). The ratio of age-0 shoal bass to age-0 largemouth bass was 6.9:1 in shoals and 1.4:1 in pools, suggesting shoal habitat as important spawning or nursery areas. Age-0 shoal bass were associated with higher than average percentage of rocky substrate in pools, but not shoals, and larger shoal bass were associated with higher than average percentage of rocky substrate in pools and shoals. Neither was associated with lower than average current speeds in either pools or shoals (Wheeler and Allen 2003).

Food: The shoal bass is a top carnivore, exploiting benthic and water column prey (Wright 1967; Hurst 1969; Wbeeler and Allen 2003). Adult food consists primarily of fishes (e.g., darters, madtom catfish, minnows, *Lepomis* spp.), crayfishes, and to a much lesser extent, insects. Fish and crayfish comprise >90% of the diet biomass in fish >140 mm TL. At 40 to 140 mm TL, small shoal bass transition from diets dominated by aquatic insect larvae (e.g., mayflies) to increased consumption of fish and crayfish (Wright 1967; Wheeler and Allen 2003).

Reproduction: Females reach maturity at minimum sizes of 152 to 189 mm SL and age 2+, but most mature at age 3+ (Wright 1967; Hurst 1969; Hurst *et al.* 1975). On the basis of occurrence of ripe, partially spent, or recently spent females and observations in ponds, spawning occurs from April to May (perhaps into June) at water temperatures from 18.0 to 26.0°C. Ripe, presumably prespawning, females are taken at temperatures as low as 14.4°C in early April (Wright 1967; Hurst 1969; Smitherman and Ramsey 1972; Williams and Burgess 1999). Nests are circular depressions about 30 to 92 cm in diameter and 5 to 15 cm deep. In streams, nests are located in shallow water (20–45 cm deep) of pools upstream of riffles or in eddies adjacent to shoals, and in culture ponds, nests were excavated at water depths of 76 to 130 cm over clay, soft clay rubble, or plant roots (Wright 1967; Hurst 1969; Williams and Burgess 1999). Males reportedly vigorously guard the nest (Williams and Burgess 1999). Observations of a single spawning pair indicated an apparently typical *Micropterus* spawning sequence that lasted about 45 minutes and resulted in deposition of about 1000 large (2-mm diameter), amher-colored, adhesive eggs. While over the nest, the pair assumed a blotched coloration of dark green vertical bars on a background color of bronze. Other nests contained 500 to 3000 ova (Williams and Burgess 1999). Fecundity increases with female size but is not well quantified. The nnmber of eggs (unclear whether total or mature) in five mature females ranged from 5396 eggs at 314 mm SL and 884 g to 21,799 eggs at 442 mm SL and 2314 g (Wright 1967). Eggs hatch in about 2 days at 21.1°C (Smitherman and Ramsey 1972), and yolk-sac larvae, averaging 4.4 mm TL, form tight aggregations in the nest bottom. The larvae reach swim-up about 7 days after hatching and disperse about 12 to 14 days after hatching (Smitherman and Ramsey 1972; Williams and Burgess 1999).

Nest associates: None known.

Freshwater mussel host: None known.

Conservation status: The shoal bass is vulnerable throughout its native range (Warren *et al.* 2000). The species is considered critically imperiled in Florida, imperiled in Alabama, and vulnerable in Georgia (NatureServe 2006). In the Chattahoochee River, the shoal bass has disappeared from most of the main channel and declined in tributaries because of impoundments eliminating shoal habitats, increased sedimentation, and water quality degradation. Its former distributional extent in the Apalachicola and Flint rivers is also reduced by impoundments and channel dredging (Williams and Burgess 1999; Johnston 2004).

Similar species: Superficially similar to redeye bass and spotted bass. Shoal bass (92% of specimens) lack a tooth patch on the tongue (versus oval to elongate patch in spotted bass and redeye bass). In adult shoal bass, the anterior half to two-thirds of the body has dark, vertically elongated, midlateral blotches that are separated by lighter areas approximately equal to the width of the blotch (versus irregular to more quadrate blotches in redeye bass); blotches usually confluent to form a midlateral stripe in spotted bass. Shoal bass also lack white outer edges on the caudal fin (present in redeye bass) and have higher caudal peduncle scale counts (Page and Burr 1991; Gilbert 1992a; Williams and Burgess 1999).

Systematic notes: *Micropterus cataractae* is a member of a "Gulf of Mexico" clade of *Micropterus*, including all other *Micropterus* except *M. dolomieu* and *Micropterus punctulatus* (Kassler *et al.* 2002; Near *et al.* 2003, 2004). Relationships within the clade are not well resolved with *M. cataractae* placed as basal to the entire clade, sister to *Micropterus coosae*, sister to *Micropterus notius*, or basal to a clade inclusive of *M. notius, M. p. henshalli,Micropterus treculi*, and *M. salmoides* + *Micropterus floridanus* (Kassler *et al.* 2002; Near *et al.* 2003, 2004).

Importance to humans: Shoal bass are the signature fish of a productive sport fishery in the Flint River, Georgia, particularly in the upper river (Davis 2006). Anglers wade fish the shoals using fly rods and crayfish-like flies or light to medium spinning gear with a variety of spinners, crayfish imitations, popping bugs, or other bass lures. The fast water habits of the shoal bass, a restricted native range, a scrappy fighting ability, and the propensity to take a fly and dive into the rocks, all combine for an exciting and specialty black bass catch. Supplemental stocking of shoal bass is being undertaken to augment the population in the lower Flint River (Davis 2006).

13.9.2 Micropterus coosae *Hubbs and Bailey*

13.9.2.1 Redeye bass

Characteristics: See generic account for general characteristics. Elongate body, depth 0.20 to 0.24 of TL, increasing with size. Mouth large, terminal, lower jaw slightly projecting, upper jaw extends little or not at all beyond posterior edge of eye. Outline of spinous dorsal fin curved. Juncture of soft and spiny dorsal fins slightly emarginate, broadly connected. Shortest dorsal spine at emargination of fin, usually >0.75 times length of longest spine. Dorsal soft rays, usually 12, 11 to 14; anal soft rays, usually 10, 9 to 11. Gill rakers, (6)7 to 8. Lateral scales, (58)67 to 72(77); rows above lateral line, (7)8 to 9(13); rows below lateral line, (11)14 to 17(21); cheek scale rows, (8)12 to 13(16); caudal peduncle scale rows, (24)26 to 30(31); pectoral rays, (13)15 to 16(17). Small splintlike scales on interradial membranes at anal and second dorsal fin bases (>60 mm SL). Pyloric caeca, usually unbranched, 7 to 12. Teeth present or absent on glossohyal (tongue) bone (Hubbs and Bailey 1940; Ramsey and Smitherman 1972; Turner *et al.* 1991; Williams and Burgess 1999; Kassler *et al.* 2002).

Size and age: Averages 49 to 63 mm TL (range, 38–68 mm) at age 1 in streams. Growth in ponds and reservoirs can be much higher (≥125 mm TL at age 1) (Parsons 1954; Gwinner *et al.* 1975; Catchings 1979; Barwick and Moore 1983). Young-of-the-year (22–25 mm TL) stocked in forage-supplemented ponds in June reached 134 mm TL by mid-December (Smitherman and Ramsey 1972; Smitherman 1975) and in some reservoirs individuals average 122 to 125 mm TL at age 1 (Barwick and Moore 1983). Few redeye bass reach 325 mm TL, exceed 225 g, and attain age 5+ to 7+ (maximum about 470 mm TL, 1.44 kg, and age 10+) (Parsons 1954; Smitherman 1975; Carlander 1977; Barwick and Moore 1983; Page and Burr 1991; Etnier and Starnes 1993; Boschung and Mayden 2004; OutdoorAlabama 2006). Redeye bass are perhaps the slowest growing *Micropterus*. The maximum size attained even in the fastest-growing reservoir populations suggests genetically based size limitations (Barwick and Moore 1983; Moyle 2002).

Coloration: Uniquely, among all *Micropterus*, the outer margins of the caudal fin lobes in redeye bass are narrowly depigmented (in life iridescent white or frosted orange in color, may be less obvious in large individuals) (Ramsey 1975). Color above olive to deep bronze. Back to lateral midline marked with dark, vertically elongate, diamond-shaped to irregularly quadrate blotches, most evident in young, fading with age. Rows of dark spots usually evident on lower sides. Yellow-white ventral area. Iris characteristically red. Breeding males with aqua-blue to blue-green cast on lower half of head and ventral area. Young-of-the-year soft dorsal fin, caudal fin, and front of anal fin tinged brick red to orange; caudal fin lacks sharply contrasting tricolored pigmentation (Ramsey and Smitherman 1972; Page and Burr 1991; Turner *et al.* 1991; Etnier and Starnes 1993; Mettee *et al.* 1996; Boschung and Mayden 2004).

Native range: The redeye bass is native above the Fall Line from the Savannah, Altamaha, and Chattahoochee rivers and the upper Mobile Basin (Coosa, Cahaba, Tallapoosa, and Black Warrior rivers) in North Carolina, South Carolina, Georgia, Tennessee, and Alabama (Page and Burr 1991; Williams and Burgess 1999). The native or introduced status of the species in the Santee River drainage, North and South Carolina, is uncertain (Warren *et al.* 2000), but preliminary genetic analyses suggest that the population(s) in the Saluda River is introduced (F. C. Rohde personal communication, Division of Marine Fishes, North Carolina). From about 1940 through the 1960s, the species was introduced outside its native range and is now established in tributaries of the Tennessee and Cumberland rivers, Tennessee and Kentucky, and in several drainages in California (Fuller *et al.* 1999; Moyle 2002). Although often debated as native rather than introduced (e.g., Clay 1975; Koppelman and Garrett 2002), established populations in Martins Fork Cumberland River, Kentucky, were introduced deliberately by state fisheries personnel around 1950 from stock obtained in Georgia (Burr and Warren 1986). In Tennessee and Cumberland river streams, introduced redeye bass have hybridized extensively and likely introgressed with native smallmouth bass (Turner *et al.* 1991; Pipas and Bulow 1998). Some superabundant stream populations of redeye bass developed after introductions in California, where the species is associated with declines of native minnows, suckers, salamanders, and ranid frogs (Fuller *et al.* 1999; Moyle 2002).

Habitat: The redeye bass inhabits rocky, small upland creeks and small to medium upland rivers, where it is associated with pools, boulders, undercut banks, and water willow beds (Parsons 1954; Page and Burr 1991; Pipas and Bulow 1998; Moyle 2002). The species can be common even in the smallest headwater stream where few other fish and no other *Micropterus* occur (Parsons 1954; Ramsey 1975; Pipas and Bulow 1998). The redeye bass has been viewed traditionally as potentially providing a fishery in waters too cool and small for other *Micropterus* but too warm for trout (e.g., Parsons 1954; Carlander 1977). These conditions, however, are not prerequisites for establishment of thriving redeye bass populations in nonnative habitats (Pipas and Bulow 1998; Moyle 2002). Indirect evidence suggests that redeye bass make large upstream migrations to tributaries to spawn in the spring (and conversely downstream fall migrations to winter habitat) (Parsons 1954). Redeye bass are generally intolerant of ponds and most reservoirs (Parsons 1954; Wood *et al.* 1956; Webb and Reeves 1975; Moyle 2002; but see Barwick and Moore 1983).

Food: The redeye bass is an opportunistic carnivore, feeding from the surface to the bottom. The summer diet in streams consists primarily of terrestrial insects and crayfish. To a lesser extent, stream-dwelling redeye bass also consume small fishes (e.g., minnows and darters), aquatic insects, and salamanders (Parsons 1954; Smitherman 1975; Gwinner *et al.* 1975). Large redeye bass (>216 mm TL) in oligotrophic reservoirs in South Carolina are primarily piscivorous (Barwick and Moore 1983).

Reproduction: Maturity is reached at a minimum size of 120 mm TL at age 3+ in females and age 4+ in males in streams, but faster growing pond-cultured individuals matured at age 1+ (Parsons 1954; Smitherman 1975). Spawning extends from April to early July as water temperatures reach 18 to 21°C (Parsons 1954; Smitherman and Ramsey 1972; Gwinner *et al.* 1975). Practically nothing is published on male or female reproductive behaviors, and overall knowledge about the reproductive biology of redeye bass is at best sketchy. Nests are shallow, circular depressions in coarse gravel at the heads of pools (Parsons 1954). Fertilized, water-hardened eggs average 3.5 mm in diameter (Smitherman and Ramsey 1972). Relationships between female size and fecundity are unquantified. Two females of 145 and 205 mm TL contained 2084 and 2334 eggs, respectively (Parsons 1954). Eggs hatch in about 2 days at 22.8°C; yolk-sac larvae are 6.0 mm TL, and larvae are free swimming at 7 to 8 mm TL about 5 days after hatching (Smitherman and Ramsey 1972). An anecdotal account suggests that fry school for a short time relative to most *Micropterus* (Parsons 1954). In a culture pond, complete breakup of schools occurred at 16 to 25 mm TL about 14 days after swim-up, but school breakup began as early as 6 days after swim-up (Smitherman and Ramsey 1972).

Nest associates: None known.

Freshwater mussel host: Confirmed host to *L. altilis*, *Lampsilis perovalis*, *V. nebulosa*, and *V. vibex* (Haag and Warren 1997; Haag *et al.* 1999).

Conservation status: The redeye bass is secure throughout its range (Warren *et al.* 2000), but native populations on the periphery of the range are considered vulnerable (Tennessee) or critically imperiled (North Carolina) (NatureServe

2006). Obversely, the past introduction and establishment of redeye bass outside its native range now threatens the genetic integrity of populations of native *Micropterus* (Turner *et al.* 1991; Pipas and Bulow 1998).

Similar species: See accounts on Suwannee bass and spotted bass. Differs from all other *Micropterus* in having the outer margins of the caudal fin lobes narrowly depigmented (iridescent white or frosted orange in life) (Ramsey 1975; Page and Burr 1991).

Systematic notes: *Micropterus coosae* is a member of a "Gulf of Mexico" clade of *Micropterus*, including all other *Micropterus* except *M. dolomieu* and *M. punctulatus* (Near *et al.* 2003, 2004). Relationships within the clade are not well resolved with *M. coosae* placed as basal to the clade, sister to *M. cataractae*, sister to *M. punctulatus henshalli* (the Alabama spotted bass), or basal to *M. notius, M. treculi,* and *M. salmoides* + *M. floridanus* (Kassler *et al.* 2002; Near *et al.* 2003). Similarities in form, color, behavior, and ecology led most morphological taxonomists to relate *M. coosae* to *M. dolomieu* or *M. punctulatus* (e.g., Hubbs and Bailey 1940; Ramsey 1975). Data from nuclear-encoded allozyme loci and mitochondrial DNA reveal significant genetic substructuring among populations now known as redeye bass and strongly suggest the existence of multiple, and perhaps specifically distinct, evolutionary lineages (Kassler *et al.* 2002; Koppelman and Garrett 2002). The evolutionary relationships among populations of redeye bass, and of redeye bass to other *Micropterus*, particularly the Alabama spotted bass (see account on *M. punctulatus*), await thorough genetic evaluation.

Importance to humans: The attractive redeye bass is regarded as a somewhat wary, but scrappy fighter in small, wadeable streams, where it provides an exciting catch on ultralight gear combined with small lures and spinners, popping bugs and flies, or natural bait (Parsons 1954; Etnier and Starnes 1993). In its small stream habitat, redeye bass populations can provide a minimal catch-and-release fishery, but slow growth rates limit establishment of harvestable stream fisheries (Pipas and Bulow 1998).

13.9.3 Micropterus dolomieu *(Lacépède)*

13.9.3.1 Smallmouth bass

Characteristics: Elongate, slightly compressed body, depth 0.18 to 0.28 of TL, decreasing with size. Mouth large, terminal, lower jaw slightly projecting, upper jaw extends at least to below center of eye but not beyond posterior edge of eye. Outline of spinous dorsal fin curved. Juncture of soft and spiny dorsal fins slightly emarginate, broadly connected. Shortest dorsal spine at emargination of fin, usually >0.5 times the length of the longest spine. Dorsal soft rays, usually 13 or 14, 10 to 15; anal soft rays, usually 11, 9 to 12. Gill rakers, 6 to 8. Lateral scales, (64)69 to 77(81); rows above lateral line, (10)12 to 13(15); rows below lateral line, (16)19 to 23(32); cheek scale rows, (13)15 to 18(20); caudal peduncle scale rows, (26)29 to 31(33); pectoral rays, (13)16 to 17(18). Small splintlike scales on interradial membranes at anal and second dorsal fin bases (>60 mm SL). Pyloric caeca, unbranched, about 10 to 15. Teeth present or absent on glossohyal (tongue) bone (Bailey 1938; Hubbs and Bailey 1938, 1940; Smitherman and Ramsey 1972; Turner *et al.* 1991; Kassler *et al.* 2002).

Size and age: Size at age 1 is highly variable among habitats and across latitudes and ranges from 40 to 188 mm TL (median 92 mm TL) (Beamesderfer and North 1995). Large individuals can exceed 400 mm TL, weigh 1.5 to 2.5 kg, and attain age 6+ to 12+ (maximum 686 mm TL, 5.2 kg, and age 14+) (Scott and Crossman 1973; Carlander 1977; Paragamian 1984; Page and Burr 1991; Weathers and Bain 1992; Beamesderfer and North 1995; MacMillan *et al.* 2002). World angling record, 4.93 kg, Tennessee (IGFA 2006). Growth rates are similar between males and females (Carlander 1977).

Coloration: No dark lateral band. Dark brown with numerous bronze markings on scales, often with 8 to 16 indistinct vertical bars on a yellow-green to brown side. Olive brown with bronze specks above, yellow to white below. Iris usually reddish. Large male is green-brown to bronze with dark mottling on back and dark vertical bars on the side. Young (<50 mm TL) boldly patterned with vertical bars and blotches and distinct, contrasting tricolored caudal fin markings (yellowish base, black middle, whitish distal edge) (Page and Burr 1991; Etnier and Starnes 1993; Ross 2001).

Native range: The smallmouth bass is native to the St. Lawrence-Great Lakes, Hudson Bay (Red River), and Mississippi River basins from southern Quebec to North Dakota and south to northern Alabama and eastern Oklahoma (Hubbs and Bailey 1938; Page and Burr 1991). The species has been introduced widely and is now established throughout southern Canada and the United States, except in Atlantic and Gulf Slope drainages, where it is rare from south of Virginia to eastern Texas (MacCrimmon and Robbins 1975; Page and Burr 1991; Jenkins and Burkhead 1994; Snyder *et al.* 1996; Fuller *et al.* 1999).

Nonnative smallmouth bass can hybridize and introgress with native species of *Micropterus*, ultimately compromising the genetic integrity of the native bass, and as a top predator, smallmouth bass may have profound direct and indirect impacts on native fishes and whole aquatic ecosystems. The most egregious case of introgression involves the near total genetic swamping of the range-restricted Guadalupe bass, *M. treculi* (Whitmore and Butler 1982; Whitmore 1983; Whitmore and Hellier 1988; Morizot *et al.* 1991; Pierce and Van Den Avyle 1997; Koppelman and Garrett 2002). Predation effects by nonnative smallmouth bass in Canadian lakes resulted in dramatic changes in food–web dynamics and shifted the native top predator, the lake trout (*Salvelinus namaycush*), from a primary diet of littoral fishes to zooplankton. The consequences for the affected lake trout populations are potentially severe (Vander Zanden *et al.* 1999, 2004). Established, nonnative populations of smallmouth bass are also implicated in loss in diversity of nongame freshwater fishes, impacts on migrating salmon, and declines in native amphibians (Bennett *et al.* 1991; Tabor *et al.* 1993; Chapleau and Findlay 1997; Findlay *et al.* 2000; MacRae and Jackson 2001; Jackson 2002; Moyle 2002; Fritts and Pearsons 2004, 2006; Weidel *et al.* 2007).

Habitat: The smallmouth bass inhabits clear, cool, runs and pools of small to large rocky rivers and the rocky shorelines of lakes and reservoirs (Page and Burr 1991). Although frequently and justifiably described as inhabiting clearer and cooler waters than other *Micropterus*, co-occurrence with congeners across the large north-to-south range is common (e.g., Funk 1975), but abundances of smallmouth bass among mesohabitats often differ from co-occurring *Micropterus*. For example, in a Kentucky reservoir with three *Micropterus* species, smallmouth bass tended to be most abundant and largemouth bass least abundant in the oligotrophic section, and spotted bass showed highest abundance in both mesotrophic and oligotrophic sections (Buynak *et al.* 1989). Similarly, in Ozark Border streams in Missouri, abundance of smallmouth bass is related inversely to percent pool area and maximum summer water temperature, a pattern opposite to that observed for largemouth bass (Sowa and Rabeni 1995).

Across its broad range, the smallmouth bass occupies a wide variety of habitats depending on life stage, food availability, and habitat conditions, but the most consistent physical habitat association for adults in rivers, lakes, and reservoirs is proximity to submerged cover (e.g., steep drop-offs, ledges, crevices, boulders, stumps, logs, logjams). Juveniles are often associated with large substrates relative to their body size, but can also use a wide range of currents, depths, substrates, and cover types. The habitat, environmental tolerances, bioenergetics, and spatial ecology of the smallmouth bass from hatching to adult in both lake and riverine environments are documented extensively. Here the focus is to briefly introduce aspects of smallmouth bass movement in lake and riverine environments and some effects of temperature, pH, and DO on the species. A wealth of detailed information is available in the references cited in this account and many other original sources, reviews, and syntheses (e.g., Robbins and MacCrimmon 1974; Coble 1975; Coutant 1975; MacCrimmon and Robbins 1981; Rankin 1986; McClendon and Rabeni 1987; Bain *et al.* 1988; Leonard and Orth 1988; Simonson and Swenson 1990; DeAngelis *et al.* 1991, 1993; Lobb and Orth 1991; Lyons 1991; Armour 1993; Jager *et al.* 1993; Barrett and Maughan 1994; Smale and Rabeni 1995b; Walters and Wilson 1996; Peterson and Kwak 1999; Zweifel *et al.* 1999; Cooke *et al.* 2000b, 2002b; Philipp and Ridgway 2002; Whitledge *et al.* 2006; Brewer *et al.* 2007; Dunlop *et al.* 2007).

In lakes and streams, smallmouth bass rather consistently remain in home areas in summer but can make seasonal movements to specific wintering areas and traverse relatively long distances in apparent exploratory movements (e.g., 66 km) or to return to a home area after being displaced (e.g., Funk 1957; Fajen 1962; Reynolds 1965; Carlander 1977; Gerber and Haynes 1988; Kraai *et al.* 1991; Peterson and Rabeni 1996; Ridgway and Shuter 1996; Hayes *et al.* 1997; Lyons and Kanehl 2002; Bunt *et al.* 2002; Ridgway *et al.* 2002; VanArnum *et al.* 2004). In summer, adults in lakes or reservoirs occupy persistent (weeks to months) postspawning home activity areas (0.2–43 ha) that are usually along rocky shorelines (or areas of steep bottom relief), but during this time individuals may frequently shift areas occupied and, in some cases, move extensively and apparently randomly (Hubert and Lackey 1980; Kraai *et al.* 1991; Savitz *et al.* 1993; Demers *et al.* 1996; Cole and Moring 1997). The size of the activity area is related positively to fish size; larger fish tend to include depths >4 m in their activity areas, and at least some individuals occupy distinctive diurnal and nocturnal activity areas (Emery 1973; Savitz *et al.* 1993; Cole and Moring 1997). In Lake Opeongo, Ontario, smallmouth bass use the largest recorded summer home ranges among centrarchids. Average postnesting home range area is 247 ha for males and 409 ha females, but core use areas (50% use) are smaller (38.4 ha) and similar between sexes. Individual male summer home ranges show high coincidence from year to year, indicating that males in the lake return from nesting areas to the same home ranges over multiple years (Ridgway and Shuter 1996; Ridgway *et al.* 2002). Daytime movements within these large home ranges are extensive, averaging 4.8 km over 6- to 16-hour periods (about 483 m/h), but there is little activity at night (Ridgway *et al.* 2002). The differences in home range size estimates among smallmouth bass in different lakes may be attributable to methods used to estimate home range (e.g., Savitz *et al.* 1993; Cole and Moring 1997; Ridgway *et al.* 2002) but may also reflect differences in resource availability (e.g., forage, cover) or in population-specific adaptations.

Riverine smallmouth bass also show high persistence in relatively small areas throughout the summer months, but fall movement to winter habitats varies among populations (review by Lyons and Kanehl 2002). In a Missouri stream, postspawning home ranges and intrapool movement of adults were greater in summer (0.09 to 0.67 ha, up to 980 m/d at 27.5°C) than in winter (0.06 to 0.22 ha, 120 m/d at 4°C), but fish generally used the same stream sections in winter and summer, moving elsewhere only during the spawning season (Todd and Rabeni 1989). In small Ouachita Mountain streams, interpool movement of smallmouth bass in summer was high, with 35% of marked individuals moving among adjacent pools over a 3-day observation period (Lonzarich *et al.* 2000). Similarly, recolonization rates after complete removal were high; pool populations reached pre-removal abundances in 40 days (Lonzarich *et al.* 1998). Some populations of riverine smallmouth bass, particularly those in areas with severe winters, make fall migrations of several to over 100 km to wintering habitats (usually to downstream bodies of water) (e.g., Langhurst and Schoenike 1990; Peterson and Rabeni 1996; Cooke *et al.* 2000a; Lyons and Kanehl 2002; Schreer and Cooke 2002). Movement to wintering areas can involve numerous short movements with rest periods of several days, or long distances may be covered in short periods (Lyons and Kanehl 2002). For example, a smallmouth bass migrating to downstream wintering habitats in Wisconsin moved 19 km in 24 hours (Langhurst and Schoenike 1990).

Latitudinal differences in temperature and regional variation in annual temperatures exert considerable influence on smallmouth bass distribution, abundance, growth, and survival. A model using temperature, food availability, and lake depth to predict young-of-the-year growth and winter mortality accurately delimited the northern distributional limit of the species (Shuter and Post 1990). Average July temperatures <15°C prevent young-of-the-year from reaching sufficient size to overwinter, precluding long-term viability of populations on the northern edge of the range (Shuter *et al.* 1980). At northern latitudes, a short-growing season and long, cold winters combined with variability in food availability (e.g., low productivity, high competition) and hence energy reserves can dramatically increase overwinter mortality (to 100%) of young-of-the-year smallmouth bass (Oliver *et al.* 1979; Shuter *et al.* 1989; Lyons 1997; Curry *et al.* 2005). In an analysis of data for 409 smallmouth bass populations across North America, age at length was correlated negatively with mean air temperature (and degree days >10°C) (Beamesderfer and North 1995). In a study of 129 geographically widespread populations, temperature-related climate differences were significantly related to growth and were most influential in the first 4 years of life (Dunlop and Shuter 2006). On a regional scale, population structure of smallmouth bass in the Laurentian Great Lakes closely tracked changes in water temperatures over several decades. Notably, steep declines in growth and year-class strength occurred with minor temperature shifts (mean shifts <3°C) caused by global climate events (i.e. peak La Niña cooling effects and eruption of Mount Pinatubo, Philippines in 1992; King *et al.* 1999; Casselman *et al.* 2002). In the upper Mississippi River, first-year growth was also influenced strongly by temperature variation over a 14-year period (Swenson *et al.* 2002). When temperature effects were considered independent of water velocity, modeled first-year growth increased an estimated 7 mm for each 100-degree day increase in growing season temperatures. At even smaller spatial scales, rapid water temperature changes associated with sporadic flooding events in streams can dramatically reduce the probability of survival in larval smallmouth bass by affecting their ability to negotiate current and effectively forage (Larimore 2002). Similarly, minor wind-induced increases in temperature (0.6–1.3°C) (and zooplankton abundance) in downwind areas of northern lakes are implicated, although not conclusively so, in nest-site selection by males and in faster growth of young (Kaevats *et al.* 2005).

Smallmouth bass are among the most sensitive of the centrarchids to reduced pH. Field and laboratory studies demonstrate reproductive impairment at pH <6.0 and total curtailment of recruitment at pH <5.5, depending in part on antagonistic effects of Al and Ca concentrations, fish size, and energy reserves (Rahel and Magnuson 1983; Kwain *et al.* 1984; Cunningham and Shuter 1986; Kane and Rabeni 1987; Hill *et al.* 1988; Holtze and Hutchinson 1989; Shuter and Ihssen 1991; Snucins and Shuter 1991). After experimental stocking of adults in small northern lakes, population estimates over three spawning seasons indicated no recruitment at pH 4.9 to 5.2, and population size was low at pH 5.4 (4–12% of number stocked) relative to a lake with pH 5.9 (41–55%) (Snucins and Shuter 1991). Complete mortality of smallmouth bass larvae and post larvae occurred within 3 days at pH 5.1 and 180 μg/l Al and within 5 days at pH 5.5 and 203 μg/l Al (Kane and Rabeni 1987). In post swim-up larvae (3–36 days old), survival (relative to controls at pH 7) declined to 43% at pH 5.7 and to near zero at pH 5.0 (Hill *et al.* 1988). Natural stress of overwinter starvation is significantly augmented even by moderate exposures to nonlethal low pH, but tolerance increases with body size and Ca concentration (Cunningham and Shuter 1986; Shuter *et al.* 1989; Shuter and Ihssen 1991). An exposure to pH 5.5 increases overwinter starvation loss by

16%, a loss rate that could significantly affect viability of smallmouth bass populations by increasing young-of-the-year starvation (Shuter *et al.* 1989).

Smallmouth bass are more sensitive to hypoxia than many other centrarchids. Of five tested centrarchids (three *Lepomis* spp. and largemouth bass), smallmouth bass showed the highest critical DO concentration (average, 1.19 mg/l at 26°C) (Smale and Rabeni 1995a). Across graded levels of hypoxia, blood plasma adrenalines and noradrenalines, which are indicators of stress, dramatically increased in the blood of smallmouth bass but not largemouth bass. Increases in ventilation rate and decreases in cardiac output also were more pronounced in smallmouth bass than in largemouth bass (Furimsky *et al.* 2003). The differential physiological responses of the two species to hypoxia are likely attributable to differences in the ability of their blood to bind DO (Cech *et al.* 1979; Furimsky *et al.* 2003).

Food: The smallmouth bass is an opportunistic, top carnivore, feeding from the surface to the bottom. The biomass of the adult diet is predominately fish, and if available, crayfish, but adult smallmouth bass also consume an occasional terrestrial vertebrate (e.g., frog) and a wide variety of aquatic and terrestrial insects, the latter being most commonly eaten in small lakes and streams. In lakes and reservoirs with few crayfishes, individuals of >100 mm TL almost exclusively eat fish (e.g., clupeids, *Lepomis*, yellow perch), but if crayfish are present, individuals of <300 mm TL consume large volumes of crayfish (Applegate *et al.* 1967; Hubert 1977; Danehy and Ringler 1991; Gilliland *et al.* 1991; Scott and Angermeier 1998; Liao *et al.* 2002; Dunlop *et al.* 2005b). Young smallmouth bass initially consume microcrustaceans and a wide variety of small aquatic insects, especially dipteran and mayfly larvae, and other invertebrates but transition between 20 and 100 mm TL to the adult diet. The breadth and extent of diet and timing of ontogenetic dietary shifts vary considerably in smallmouth bass in response to interactions among habitat quality, competition, and prey availability (e.g., Hubbs and Bailey 1938; Applegate *et al.* 1967; Clady 1974; Carlander 1977; George and Hadley 1979; Probst *et al.* 1984; Angermeier 1985; Livingstone and Rabeni 1991; Easton and Orth 1992; Rabeni 1992; Roell and Orth 1993; Sabo and Orth 1994, 2002; Sabo *et al.* 1996; Easton *et al.* 1996; Pelham *et al.* 2001; Orth and Newcomb 2002; Pert *et al.* 2002; Olson and Young 2003; Dunlop *et al.* 2005b).

In streams, energy from crayfishes may provide over half the total production of smallmouth bass and over 60% of the energy of adult smallmouth bass, the remainder being obtained from fishes, particularly cyprinids such as stonerollers (*Campostoma* sp.) (Rabeni 1992). In these systems, smallmouth bass can remove about a third of crayfish production and nearly two-thirds of the biomass of crayfishes of vulnerable size. Most crayfish eaten are between 14 and 46 mm (carapace length), even though the available size range of crayfish in the streams is much larger and changes seasonally (Rabeni 1992; Roell and Orth 1993). Interestingly, in a Missouri stream, the size of smallmouth bass and the size of crayfishes eaten were not related. Gape limitation or other morphological constraints apparently were not operative, but rather, there was an optimum size range of crayfishes common to all sizes of bass (>100 mm TL) (Probst *et al.* 1984). In a northern lake and associated laboratory research, size of crayfish prey was related positively to smallmouth bass size, but complex interactions of substrate type and crayfish size, sex, and life stage affected bass selectivity (Stein 1977). Smallmouth bass foraging behaviors appear well adapted for benthic prey. Compared to largemouth bass, foraging smallmouth bass keep the body more horizontal in inspecting the bottom, remain closer to the substrate, and use biting actions more often in feeding. The species uses combinations of suction feeding and grasping and jerking to dislodge crayfishes from rock crevices, but largemouth bass rely primarily on suction feeding (Winemiller and Taylor 1987).

Smallmouth bass are primarily diurnal in habit with activity typically greatly diminishing at night. Feeding and activity peaks are often noted at dawn or dusk, but fish can feed opportunistically over a 24-hour period (Munther 1970; Reynolds and Casterlin 1976b; Helfman 1981; Gerber and Haynes 1988; Todd and Rabeni 1989; Kwak *et al.* 1992; Johnson and Dropkin 1993; Demers *et al.* 1996; Ridgway *et al.* 2002). Nighttime samples taken in the fall in a Pennsylvania river revealed food in stomachs (primarily mayfly larvae and crayfish by weight) of over 60% of smallmouth bass examined (65–346 mm TL, n = 60) (Johnson and Dropkin 1993). Nighttime angling in summer in the Tennessee River, Alabama, accounts for a substantial proportion of the smallmouth bass catch (Weathers and Bain 1992), also suggesting nighttime feeding or at least a propensity to feed at night. Prey consumption by smallmouth bass is affected by turbidity. The reactive distance of smallmouth bass (99 mm TL) to 10-mm prey (dipteran larvae) decreased exponentially from about 65 to 10 cm as turbidity increased from <5 to 40 NTU (at 49 lux) in laboratory trials (Sweka and Hartman 2003).

As highly effective top predators, smallmouth bass can cause shifts in fish assemblages, redistribution or elimination of prey, and dramatic changes in prey behavior. In small Ontario lakes, the presence of smallmouth bass was linked to reduced abundance, altered habitat use, and extirpation of a suite of small-bodied fishes, primarily cyprinids and brook stickleback (MacRae and Jackson 2001). Similar direct and indirect interactions of small-bodied fishes and predation by smallmouth bass are documented across lakes in southern Canada and the northeastern United States (e.g., Chapleau and Findlay 1997; Whittier *et al.* 1997; Whittier and Kincaid 1999; Vander Zanden *et al.* 1999, 2004; Findlay *et al.* 2000; Jackson 2002; Morbey *et al.* 2007). In experimental and natural streams, several small-bodied fish species shifted habitat use from deep pools to the refuge of shallow-flowing habitats when smallmouth bass were present (Schlosser 1988a,b, but see Harvey *et al.* 1988). In experimental tanks with smallmouth bass, the benthic-dwelling johnny darter (*Etheostoma nigrum*) reduced activity to 6% of that observed in tanks without bass, spending most of the time under tile shelters. Even after removal of the bass, darters remained inactive and under shelters for about 24 hours, indicative of a strong residual effect of the predator's presence (Rahel and Stein 1988). In field and laboratory trials, predation risk from smallmouth bass induced shifts in microdistribution (e.g., larger substrate use, hiding in burrows) and behavior (e.g., reduced walking, climbing, and feeding) of small lake-dwelling crayfish, and in experimental streams, the presence of smallmouth bass reduced crayfish activity, aggressive behaviors, and pool use (Stein and Magnuson 1976; Stein 1977; Mather and Stein 1993). Interestingly, daytime larval minnow abundance was influenced differentially by the presence of juvenile and adult smallmouth bass in natural and experimentally manipulated stream pools. Minnow larvae were less abundant in pools with juvenile smallmouth bass and more abundant in pools with adult smallmouth bass. The presence of adult smallmouth bass in a pool apparently reduced the risk to larval fish of predation from juvenile bass and other predators (e.g., *Lepomis*) (Harvey 1991b).

Reproduction: Depending in part on latitude, females mature minimally at age 3+ to 7+ ($\geq$220 mm TL) and males at age 2+ to 5+ ($\geq$200 mm TL) (Carlander 1977; Hubert and Mitchell 1979; Vogele 1981; Serns 1984; Raffetto *et al.* 1990; Ridgway and Friesen 1992; Wiegmann *et al.* 1992; Dunlop *et al.* 2005a,b). Male size appears more important than age in attaining maturity (Wiegmann *et al.* 1997; Dunlop *et al.* 2005a).

Many smallmouth bass populations make regular spring migrations to spawning areas and exhibit a high degree of nest-site fidelity. Patterns of spring movements, some involving relatively long distances (5–75 km), from wintering to spawning areas are documented in populations inhabiting streams, rivers, lakes, and reservoirs (e.g., Reynolds 1965; Hubert and Lackey 1980; Todd and Rabeni 1989; Kraai *et al.* 1991). Movement associated with spawning appears to be population or context specific, perhaps reflecting suitability and availability of nesting sites. Individuals may move to spawning areas and stay until fall, move to spawning areas and then return to home areas after spawning, or spawn in the general area where they occur all year (e.g., Pflieger 1975; Todd and Rabeni 1989; Lyons and Kanehl 2002). Some lake-dwelling populations make large, regular spring migrations of >10 km into lake tributaries to spawn, returning to the lake after reproduction (Lyons and Kanehl 2002), and others consistently use nesting areas within a lake that are spatially distinct from nonspawning home areas. Over a multiyear, multigenerational field study in a Canadian lake, >71% of renesting smallmouth bass males returned to within 100-m linear distance of their previous year's nest site, even though nest habitats were not limiting. In subsequent years, about 35% returned to within 20 m of their original nest site, nesting largely in or adjacent to their old nest (Ridgway *et al.* 1991a, 2002). Nest aggregations along lake shorelines are consistently patchy across years (Rejwan *et al.* 1997), indicative of selection of specific nesting areas, and genetic analyses of offspring from individual nests further support high nest-site fidelity in the species (Gross *et al.* 1994).

In natural settings, smallmouth bass spawn from about April to mid-July at southern latitudes and mid-May to mid-June on the northern edge of the range (Pflieger 1966a, 1975; Neves 1975; Hubert and Mitchell 1979; Vogele 1981; Wrenn 1984; Graham and Orth 1986; Ridgway and Friesen 1992). A second spawning period or multiple renestings may occur, especially if early broods are lost because of high flows and temperature decreases (Beeman 1924; Surber 1943; Pflieger 1966a, 1975; Coble 1975; Neves 1975; Lukas and Orth 1995; Cooke *et al.* 2003a, 2006). Spawning activity and active nests span a broad range of temperatures (12.0–26.7°C); however, most spawning is initiated as water temperatures gradually rise and exceed 15°C, and peak spawning continues to 22°C (e.g., Pflieger 1966a; Smitherman and Ramsey 1972; Neves 1975; Carlander 1977; Shuter *et al.* 1980; Vogele 1981; Wrenn 1984; Graham and Orth 1986; Cooke *et al.* 2003a). Large mature males nest earlier (i.e. at lower temperatures and fewer accumulated degree days >10°C before spawning) than small mature males; females show similar size-related timing in spawning (Ridgway *et al.* 1991b; Wiegmann *et al.* 1992; Baylis *et al.* 1993; Lukas and Orth 1995). Smallmouth bass from the Tennessee River exposed to water temperatures of 2.6, 5.2, and 8.0°C above ambient temperature (beginning in December) showed spawning peaks of 9, 16, and 25 days, respectively, before control fish exposed to ambient river water temperatures (Wrenn 1984). Likewise, in a thermally unstable, but heated effluent canal in Lake Erie, spawning of smallmouth bass was advanced about 1 month relative to spawning in the lake (Cooke *et al.* 2003a). Simulated, compressed winter conditions (short photoperiods, temperatures ~ 6°C) followed by

20 to 22 days of exposure to increasing photoperiod (14 hours) and temperature (18°C) induces out-of-season spawning, but increasing temperature alone does not appear to induce spawning (Cantin and Bromage 1991).

Male smallmouth bass establish a territory and use caudal sweeping to excavate a circular depressional nest down to coarse gravel–cobble substrates, bedrock, or even hard clay. Nests average 45 to 93 cm in diameter and are often near (or just downstream of) rocky or woody cover. In lakes and reservoirs, nests are usually placed in water <4.0 m deep (to 6.7 m). In streams, nests are placed in low-velocity habitats, usually in water <0.75 m deep (Surber 1943; Pflieger 1966a; Neves 1975; Vogele and Rainwater 1975; Carlander 1977; Vogele 1981; Winemiller and Taylor 1982; Lukas and Orth 1995; Bozek *et al.* 2002; Orth and Newcomb 2002; Saunders *et al.* 2002; Bozek *et al.* 2002; Steinhart *et al.* 2005). In riverine habitats, smallmouth bass nests generally are spaced widely, rarely exceeding 3/100 m, although average internest distances of 4.2 m are reported (Surber 1943; Pflieger 1966a, 1975; Coble 1975; Lukas and Orth 1995; Knotek and Orth 1998). In lakes, nesting areas are patchily, but nonrandomly, distributed, and highest nest densities occur in areas with >17.0°C water temperatures and high shoreline complexity (Rejwan *et al.* 1997). Within a nesting area in lakes, densities are usually 1 to 5 nests/100 m of shoreline, but even when highly concentrated, nest density rarely exceeds 7 nests/100 m of shoreline (Vogele 1981; Scott 1996; Rejwan *et al.* 1997, 1999; Saunders *et al.* 2002). Nest spacing in lakes matches the shape and size of the male's territory ($\geq$18 m apart) and the area needed for foraging of the free-swimming brood but is much greater than that predicted for randomly established nests (Scott 1996). Greater internest spacing and presence of cover increases the probability of mating success of male smallmouth bass (Winemiller and Taylor 1982; Wiegmann *et al.* 1992).

Once the nest is prepared, the male engages in long periods of fanning with the pectoral and median fins. The male intersperses bouts of fanning with frequent reorientation of his longitudinal axis by pivoting the body around the center of the nest (45–90°/turn; 0.5–1.2 turns/s), the pivots being an apparent effort to detect rivals or females around the nest (Beeman 1924; Pflieger 1966a; Winemiller and Taylor 1982). Depending in part on availability of females, elapsed time between nest construction and egg deposition is usually 2 days, but ranges from a few hours up to 16 days (Pflieger 1966a; Wrenn 1984; Ridgway *et al.* 1991b). Males periodically leave the nest to locate spawning-ready females and once located, use push–lead behaviors (jaw displays, contact nips) to direct the female to the nest (Ridgway *et al.* 1989). During courtship and spawning, the male's iris becomes bright red, and the female develops a series of dark vertical bars or mottlings against a light background that are lacking in the breeding male (Breder and Rosen 1966; Schneider 1971; Ridgway *et al.* 1989). In response to male courtship, the spawning-ready female assumes a head-down posture and under coaxing from the male slowly moves toward the nest, where the pair begins circling high above the nest (male below, female above), slowly descending toward the nest as they circle. Ultimately, the pair starts circling the nest rim (female inside, male outside). During circling, the male contact nips the female's opercle and ventral area (pelvic fins to vent). Finally, the two settle to the substrate, the female performs a body wave (i.e. a gentle swinging of her head and caudal peduncle from side to side while in an upright position and close beside the male), tilts to the side, places her vent near the male's vent, and quivers while releasing eggs. The male remains upright during milt release. After egg release, the female rises above the nest in a head-down posture. The complete sequence of rim circling, male to female contact nips, and female quivering occurs repeatedly with brief pauses in between sequences (Schneider 1971; Ridgway *et al.* 1989). The complete spawning bout with a female can last >2 hours and involve 103 female shudders at 30- to 60-second intervals with up to 50 eggs released per shudder. On completion of the bout, the male drives the female from the nest (Reighard 1906; Schneider 1971; Neves 1975). Multiple complete spawning observations, female batch fecundity, and egg developmental stages in nests in natural settings indicate that most males mate with one female, but some males may mate sequentially (or simultaneously) with more than one female (Beeman 1924; Hubbs and Bailey 1938; Neves 1975; Vogele 1981; Ridgway *et al.* 1989; Wiegmann *et al.* 1992). Large guardian males are more likely to successfully attract and spawn with females, but in some populations, many males of various sizes build nests but are unsuccessful in attracting mates (Winemiller and Taylor 1982; Wiegmann *et al.* 1992; Baylis *et al.* 1993). Of males spawning with females, large guardian males receive more eggs and defend the brood more tenaciously than small guardian males, ultimately producing larger broods, which may in part explain the apparent female mate preference for larger males (Neves 1975; Ridgway and Friesen 1992; Lukas and Orth 1995; Wiegmann and Baylis 1995; Wiegmann *et al.* 1992, 1997; Knotek and Orth 1998).

Mature ovarian eggs average from 1.60 to 2.75 mm diameter, and fertilized, water-hardened eggs from 2.0 to 3.5 mm diameter (Meyer 1970; Smitherman and Ramsey 1972; Hubert 1976; Vogele 1981; Wrenn 1984; Cooke *et al.* 2006). Fecundity increases with female weight, length, and age (Clady 1975; Hubert 1976; Kilambi *et al.* 1977; Vogele 1981; Serns 1984; Dunlop *et al.* 2005b). Bimodal egg size classes occur in ovaries of spawning-ready females, suggesting that females have the potential to spawn multiple batches of eggs in a single spawning season. However, over the relatively short spawning season secondary stage ova do not appear to mature after the initial batch is spawned, being resorbed in summer (Hubert and Mitchell 1979; Vogele 1981). The relationship between potential batch fecundity (Y) and total weight or length (X) are described by the linear functions, $Y = -1,347 + 13.65X$, where X is weight in grams ($n = 21, R^2 = 0.85$), or $Y = -1225.15 + 59.39X$, where X is TL ($n = 74, R^2 = 0.39$) (formulas from Vogele 1981 and Raffetto *et al.* 1990, respectively; see also, Hubert 1976; Kilambi *et al.* 1977; Dunlop *et al.* 2005b). At 549 g (about 335 mm TL), a female can potentially produce 6147 mature eggs in a single batch (range: 1724 eggs at 221 g to 21,467 eggs at 1471 g). Average number of eggs per nest ranges from 2149 to 7757 (>19, 000 in some nests) (Pflieger 1966a; Clady 1975; Neves 1975; Vogele 1981; Raffetto *et al.* 1990; Wiegmann *et al.* 1992). The adhesive, grayish white to pale yellow fertilized eggs hatch in 6.4 days at 16°C (2.4 days at 22°C, from formula in Shuter *et al.* 1980). Larvae are 4.4 to 6.8 mm TL at hatching, and depending on water temperature, are free swimming at a size of 8.1 to 10.1 mm TL in 4 to 16 days after hatching (Reighard 1906; Beeman 1924; Tester 1930; Hubbs and Bailey 1938; Meyer 1970; Hardy 1978; Shuter *et al.* 1980; Vogele 1981; Wrenn 1984; Ridgway and Friesen 1992).

At swim-up, smallmouth bass fry begin a diel cycle of moving away from the nest at dawn and returning to the nest at dusk, and the guardian male shows parallel behavior (Ridgway 1988). During the swim-up phase, the brood disperses over about 13.4 m^2 relative to the guardian male's nest range of 22.7 m^2. Later, during the juvenile guarding phase, the brood disperses in the day time over 82.4 m^2, and the male over 176.9 m^2. At dusk, fry and male ranges decrease to 3.1 and 20.7 m^2, respectively. The male apparently responds to changes in brood dispersal and not vice versa, because the diurnal contraction and expansion of the brood continues when males are removed (Scott *et al.* 1997). Juvenile smallmouth bass show nest-site fidelity. In an Ontario lake, age-0 smallmouth bass dispersed little beyond 200 m of their nest of origin by fall, a time long after parental males ceased brood guarding (Gross and Kapuscinski 1997; Ridgway *et al.* 2002). Likewise, stream-dwelling age-0 smallmouth bass appear to remain near the spawning areas for the first summer of life (Lyons and Kanehl 2002).

Male smallmouth bass guard and vigorously defend the nest, eggs, and larvae 24 h/d for 2 to 7 or more weeks, depending in part on male size and energy reserves, spawning time, and water temperatures (e.g., Pflieger 1966a; Neves 1975; Vogele 1981; Hinch and Collins 1991; Ridgway and Friesen 1992; Scott *et al.* 1997; Knotek and Orth 1998; Cooke *et al.* 2002a; Cooke *et al.* 2006). Over eight nesting seasons in a northern lake, average duration of male parental care ranged from 9.4 to 16.4 days (up to 21 days) before swim-up and 9.2 to 11.8 days after swim-up (up to 27 days) (Ridgway and Friesen 1992). Male defense behaviors and swimming activity increase as the offspring progress from egg to hatching, peak before swim-up, and begin to decrease after swim-up (Ridgway 1988; Ongarato and Snucins 1993; Cooke *et al.* 2002a). Nevertheless, males shift from active and close defense of a brood confined to the nest before swim-up to more distant but vigilant patrolling of dispersed larvae and juveniles (Scott *et al.* 1997). Guardian male feeding is curtailed or at least dramatically reduced, which in turn reduces and perhaps depletes energy reserves (Hinch and Collins 1991; Gillooly and Baylis 1999; Mackereth *et al.* 1999; Cooke *et al.* 2002a; Steinhart *et al.* 2005). Large males show higher intensity and longer duration of offspring defense; small guardian males can abandon the brood early or may show little or no defense of juveniles, perhaps as a result of reduced or depleted energy reserves (Ridgway and Friesen 1992; Philipp *et al.* 1997; Mackereth *et al.* 1999). Males experiencing brood loss from simulated predation also show less nest defense and are more likely to completely abandon the brood (Philipp *et al.* 1997; Suski *et al.* 2003).

Compelling evidence of an alternating life history strategy is documented for a smallmouth bass population in Nebish Lake, Wisconsin. Unlike the alternative reproductive strategy of cuckoldry seen in some male *Lepomis*, successive generations of male smallmouth bass in this population alternate their age at first reproduction between ages 3 and 4 (Raffetto *et al.* 1990; *et al.*Wiegmann *et al.* 1992, 1997; Baylis *et al.* 1993). *Micropterus* males are typically iteroparous (reproducing in multiple years), but males in this closed population are essentially semelparous (reproducing once in a lifetime). Reproduction can begin at age 3, but the life history decision for time of first reproduction is conditional on male size at age 3, with large age-3 males being likely to reproduce, and small age-3 males being likely to delay reproduction until age 4 or older. In turn, size at age 3 is determined largely in early ontogeny and is likely a function of birth date. Large, older males (age 4 or older) spawn earlier (average about 4–5 days) in the spring than mature, spawning age-3 males. The late spawning, age-3 males are more likely to produce a cohort of small age-3 males that in turn are more likely to delay reproduction until age 4 or older. Conversely, small age-3 males that delay reproduction until age 4 (or older) are more likely to produce a cohort of large, reproductively active age-3 males. Hence, an alternation of time to maturation is sustained over multiple years and appears to be mediated by just a few days difference in birth date (Baylis *et al.* 1993; Wiegmann *et al.* 1997).

Nest associates: Longnose gar, *Lepisosteus osseus* (Goff 1984); common shiner, *Luxilus cornutus* (Hunter and Wisby 1961); orangethroat darter, *Etheostoma spectabile* (Pflieger 1966b).

Freshwater mussel host: Confirmed host to *A. ligamentina, L. cardium, L. fasciola, L. higginsii, L. radiata, L. rafinesqueana, L. reeviana, L. siliquoidea*, and *V. iris* (Coker *et al*. 1921; Zale and Neves 1982; Waller and Holland-Bartels 1988; Barnhart and Roberts 1997; O'Dee and Watters 2000). Putative host to *Lampsilis abrupta* and *Lexingtonia dolabelloides* (unpublished sources in OSUDM 2006).

Conservation status: The smallmouth hass is secure throughout its range, but native populations in Kansas, along the western periphery of the natural range, are considered vulnerable (NatureServe 2006).

Similar species: Spotted bass have a black midlateral stripe (no vertical bars) and rows of black spots along the lower sides; redeye bass have white or orange edges on the caudal fin lobes and rows of black spots along the lower sides; Florida bass and largemouth bass have a dark, midlateral stripe, a deep notch between the soft and spiny dorsal fins, and in adults, the mouth reaches beyond the rear margin of the eye (Page and Burr 1991).

Systematic notes: *Micropterus dolomieu* and *M. punctulatus* form a sister pair, which is basal to all other *Micropterus* (Kassler *et al*. 2002; Near *et al*. 2003, 2004, 2005). Morphological taxonomists traditionally related *M. dolomieu* to *M. coosae* (Hubbs and Bailey 1940; Ramsey 1975). Although only two subspecies of *M. dolomieu* are usually recognized, the species as currently conceived appears to consist of several distinct evolutionary lineages. The subspecies *M. d. velox* was described from tributaries of the Arkansas River in southwestern Missouri, northeastern Oklahoma, and northwestern Arkansas based on color, body shape, and modal differences in dorsal ray counts (Hubbs and Bailey 1940). Intergrade populations between *M. d. dolomieu* and *M. d. velox* were considered tentatively to occupy the remainder of the southern Ozark and Ouachita uplands, exclusive of the lower Missouri River, and *M. d. dolomieu* the remainder of the range. Limited sampling of mitochondrial and nuclear DNA sequences did not detect geographic differences among *M. dolomieu* populations (Kassler *et al*. 2002; Near *et al*. 2003, 2004), but nuclear-encoded allozyme loci provide evidence for significant genetic substructuring in the Ozark and Ouachita uplands (Stark and Echelle 1998). Three different clades of *M. dolomieu* inhabiting the Ozark and Ouachita uplands are evident: (1) the Ouachita smallmouth bass in the Little and Ouachita river drainages; (2) the Neosho smallmouth bass from the southwestern Ozarks in the Neosho and Illinois rivers and smaller tributaries of the middle Arkansas River; and (3) a clade comprising all other populations on the Ozark Plateau (White, Black, St. Francis, Meramec, and Missouri rivers). The latter clade was similar genetically to populations from the upper Mississippi and Ohio River basins (Stark and Echelle 1998).

Importance to humans: The smallmouth bass is rivaled only by the Florida bass and the largemouth bass as the most sought-after and valued species in the black bass recreational fishery. Until at least 1932, tons of smallmouth bass were taken commercially by hook and line and by net in Canada, until the species was restricted as a noncommercial sport fish (Scott and Crossman 1973). The smallmouth bass reaches a relatively large size, is an intense, strong fighter when hooked, and over its broad distribution flourishes in high-quality lakes, reservoirs, and upland rivers and streams, all attractive attributes to recreational anglers. As a primary North American recreational fish, the smallmouth bass is the focus of intense fisheries research and management efforts increasingly aimed at maintaining quality- and trophy-size catches for anglers (e.g., Reed *et al*. 1991; Beamesderfer and North 1995; Kubacki *et al*. 2002; Noble 2002). Not unexpectedly, techniques for catching smallmouth bass are the subject of a continuous stream of media from the recreational fishing industry (e.g., magazine articles, books, videos). Like other black bass the species is taken by a number of methods including dry flies, wet flies, popping bugs, lures, spinners, jigs, and plastic worms. Effective natural baits include leeches, soft crayfish, hellgrammites, minnow-tipped jigs, frogs, and salamanders. Although most often taken in lakes and reservoirs, smallmouth bass anglers, particularly a growing contingent of fly fishers seeking a quality fishing experience, wade or fish from small boats and canoes in scenic upland streams and rivers (Becker 1983; Etnier and Starnes 1993; Pflieger 1997). The flesh is white, firm, and flaky with fine flavor, being regarded by gourmets as superior table fare (Becker 1983).

13.9.4 Micropterus floridanus *Lesueur*

13.9.4.1 Florida bass

Characteristics: See generic account for general characteristics. Elongate, slightly compressed body, depth about 0.24 to 0.29 of TL, increasing with size. Mouth large, terminal, lower jaw slightly projecting, upper jaw extends beyond posterior edge of eye in adults. Outline of spinous dorsal fin sharply angular. Juncture of soft and spiny dorsal fins deeply emarginate, almost separate. Shortest dorsal spine at emargination of fin, usually 0.3 to 0.4 times the length of longest spine, membranes between short spines deeply incised. Dorsal soft rays, usually 13, 12 to 14; anal soft rays, usually 11, 10 to 12. Gill rakers, 6 to 9. Scales average smaller than largemouth bass. Lateral scales, (65)69 to 73(76); rows above lateral line, (7)8 to 9(10); rows below lateral line, (15)17 to 18(21); cheek scale rows, (10)11 to 13(14); caudal peduncle scale rows, (27)28 to 31(33); pectoral rays, 14 to 15(16). No small splintlike scales on interradial membranes at anal and second dorsal fin bases. Pyloric caeca branched at bases, 26 to 43 or more. Tooth patch absent (rarely a few teeth) on glossohyal (tongue) bone (Bailey and Hubbs 1949; Buchanan 1973; Chew 1974; Ramsey 1975; Kassler *et al*. 2002).

Size and age: Size at age 1 ranges from 142 to 310 mm TL for males and 116 to 330 mm TL for females (Allen *et al*. 2002). Age and weights of trophy Florida bass ($n = 810$, ≥ 4.5 kg) obtained from taxidermists across Florida revealed a maximum age of 16 (average 9.7 years), a maximum weight of 7.9 kg (average 5.0 kg), and a maximum length of 762 mm TL (average 661 mm) (Crawford *et al*. 2002). Florida state record, 7.85 kg (FFWCC 2006). Females grow faster and live longer than males; nearly all large individuals of Florida bass (>400 mm TL) are females (Allen *et al*. 2002; Crawford *et al*. 2002; Bonvechio *et al*. 2005; all cited studies include a few likely populations of *M. floridanus* × *M. salmoides* intergrades in northern Florida).

Coloration: Broad dark olive to olive black, midlateral stripe on caudal peduncle becoming disrupted anteriorly into a series of more or less distinct blotches, the midlateral stripe often faint in large adults. Silver to brassy green above (brownish in tea-stained water) with dark olive mottling. Scattered dark specks on lower sides; whitish below. Iris brown. Young (<50 mm TL) with bicolored caudal fin markings (whitish basally, dark distally) (Bailey and Hubbs 1949; Chew 1974; Page and Burr 1991).

Native range: The Florida bass is native to peninsular Florida (Bailey and Hubbs 1949; Philipp *et al*. 1981, 1983; Page and Burr 1991). The Florida bass and largemouth bass have an extensive hybrid zone across the southeastern United States in large part as a result of stocking of Florida bass outside its native range (see account on *M. salmoides*).

Habitat: The Florida bass inhabits clear vegetated lakes, reservoirs, canals, ponds, swamps, and backwaters, as well as pools of creeks and small to large rivers (Page and Burr 1991). Adults often center home activity areas in close association with structure (e.g., logs, piers) or mixed beds of emergent and submergent aquatic macrophytes but also frequent open water without cover (McLane 1948; Mesing and Wicker 1986; Colle *et al*. 1989; Bruno *et al*. 1990). Young Florida bass are usually most abundant in shallow (<2 m) densely vegetated areas (McLane 1948; Chew 1974; Allen and Tugend 2002). Maximal home activity area of radio-tagged adult Florida bass in two lakes was 5.2 ha, averaging about 1.2 ha for fish tracked over multiple months and seasons. Fish size was related positively to home area, and mean daily movements decreased at seasonal high and low temperatures (Mesing and Wicker 1986). Home activity areas were generally narrow and paralleled the shore for distances of 50 to 2364 m. Most activity (70–90%) was <300 m from the geometric center of the home use area. The largest fish (>600 mm TL) occupied the same home areas for over a year. Nevertheless, considerable offshore movement occurred, and many fishes were not located in littoral areas for long periods, suggesting that a significant proportion of Florida bass used open water extensively (Mesing and Wicker 1986). In a lake lacking aquatic macrophytes, some radio-tagged Florida bass consistently used offshore home areas at depths >3.5 m. The offshore home activity areas lacked any natural or artificial structures. The offshore fish had larger home activity areas (mean 21.0 ha, range 0.6–39.5 ha) than similar-sized fish occupying shallow (<2.0 m) inshore home areas associated with standing timber (mean 4.1 ha, range 1.0–9.8 ha). Although much Florida bass activity is associated with dawn and dusk, movement occurs throughout the day. Interestingly, nocturnal movement of Florida bass can be high, extending into the early morning hours, especially when water temperatures exceed 18°C (Mesing and Wicker 1986; Colle *et al*. 1989).

The Florida bass, having evolved in a subtropical climate, is more adapted to high temperatures and apparently less adapted to low temperatures than its temperate climate sister species, the largemouth bass. The Florida bass, along with the bluegill, has the highest reported critical thermal maxima among centrarchids, exceeding 41°C (acclimation temperatures >30°C, Fields *et al*. 1987; Beitinger *et al*. 2000). Hatching success of eggs and early development of larvae in Florida bass require greater thermal input than in largemouth bass (Philipp *et al*. 1985a). When held for 5 days at 2°C, Florida bass showed higher mortality rates (48%) than largemouth bass (0%), and in Illinois ponds, Florida bass showed significantly lower overwinter survival than largemouth bass (Carmichael *et al.* 1988; Philipp and Whitt 1991). The differences in response to temperatures between the two species appear to be linked to divergence in gene regulatory processes (Philipp *et al.* 1983, 1985b; Parker *et al.* 1985).

Florida bass occur and persist in highly acidic lakes (pH 3.7–4.5, ≤2 mg/l Ca) with relatively high total Al concentrations (≤200 μg/l), water quality conditions unfavorable for many fishes. Growth and body condition are reduced in acidic lakes relative to populations in circumneutral lakes, but changes in blood plasma osmolarity and electrolytes, associated with pH-related stress, are not substantial. Young-of-the-year Florida bass, but no small bluegill or redear sunfish, occurred even in the most acidic lakes studied. The physiological basis for the acid tolerance of the Florida bass is unknown (Canfield *et al.* 1985).

Food: The Florida bass is a top carnivore. Adults (>300 mm TL) feed about equally on fish (e.g., other centrarchids, clupeids, anchovies, topminnows, lake chubsuckers, silversides, minnows, darters) and decapods (crayfish and grass shrimp, if available) (McLane 1948, 1950; Chew 1974; Schramm and Maceina 1986; Huskey and Turingan 2001; Crawford *et al.* 2002). Young-of-the-year (13–30 mm TL) feed heavily on cladocerans, copepods, amphipods, and aquatic insects but with growth (31–75 mm TL) cease zooplankton use and begin including higher volumes of grass shrimp and fish (e.g., mosquitofish, silversides, topminnows). By 75 mm TL, fish and decapods constitute most of the diet biomass (Carr 1942; Chew 1974; Huskey and Turingan 2001; Allen and Tugend 2002). Florida bass feed by using combinations of ram (i.e. rapid acceleration of the body) and suction (i.e. rapid expansion of buccal cavity) strike modes on prey (Sass and Motta 2002). Feeding activity appears to occur randomly during the day (Chew 1974), and in captivity, Florida bass digestion rates are rapid (relative to warmouth, *L. gulosus*), and individuals feed voraciously even when considerable food from previous meals remains in the stomach (Hunt 1960). In the St. Johns River, Florida, early naturalists reported groups of hundreds to thousands of Florida bass pursuing and feeding on enormous schools of threadfin shad. Attacks by the bass on the shad resulted in the surface boiling with activity for several minutes at a time (McLane 1948). Focal animal observations on Florida bass (<300 mm TL) in canals revealed that 75% of the individuals occurred in hunting groups. Large individuals (>300 TL) hunted only with groups of other bass, but small individuals (<300 mm TL) hunted in mixed species groups with similar-sized bluegills (Annett 1998). The mixed groups searched, lunged into vegetation, and struck at schools of small fishes together. The bass-only groups typically oriented toward and surrounded a vegetated area, then one bass flushed a prey fish, and the entire group then pursued the prey. The group then moved to another vegetated patch and repeated the sequence of behaviors (Annett 1998), all of which are suggestive of group foraging if not cooperation.

Reproduction: Maturity is reached at age 1+ to 3+ and 254 to 299 mm TL (Chew 1974). In experimental ponds in southern Florida, individuals matured and spawned at 9 months (Clugston 1964). Gonadal development, as evidenced by gonadosomatic changes and sex hormone levels, begins increasing in November and peaks in February and March (Gross *et al.* 2002; Sepúlveda *et al.* 2002). Lake-dwelling Florida bass engage in spawning movements (≤3 km) to nesting areas protected from wind and wave action, then return to prespawning home areas after spawning (Mesing and Wicker 1986; Colle *et al.* 1989; Bruno *et al.* 1990). When low temperatures interrupted spawning activities, fish returned to their home areas in a lake, and then as temperatures rose, returned to the same canal to reinitiate spawning (Mesing and Wicker 1986). Spawning can occur as early as December in southern Florida, as water temperatures cool to about 18.3°C, but peak spawning is generally from February to April at water temperatures between about 18.0 and 21.1°C (as low as 14°C, up to about 27.8°C) (Clugston 1966; Chew 1974). In experimental ponds in Illinois, average duration of the spawning period as estimated from age differences in young was 21 days (range, 13–71 days), but initiation of spawning occurred 7 to 11 days later than largemouth bass occupying the same ponds (Isely *et al.* 1987). Males excavate nests using strong lateral undulations of the body. To further shape the nest, males position their head in the center of the nest and pivot around the nest while rapidly beating the pectoral, soft dorsal, and caudal fins (Carr 1942). Nests are oval (30–60 cm long, 20–55 cm wide), located in water 30 to 75 cm deep (range 10 cm to 2 m), and spaced as close as 1.5 m apart but usually ≥2.5 m apart (Carr 1942; Clugston 1966; Bruno *et al.* 1990). Males usually build nests near simple cover (e.g., log, overhanging tree limb, near cattail roots) over firm substrates if available. In lakes with bottoms of unconsolidated organic matter, males construct nests on spatterdock rhizomes, firm detritus in emergent grasses, and palmetto leaves over submergent vegetation (Carr 1942; Bruno *et al.* 1990). Anecdotal evidence suggests some degree of year-to-year nest site fidelity (Carr 1942). Early in the season, intervals of 4 to 5 days may occur between nest construction and spawning, but as the spawning intensifies, nests are constructed and receive eggs within a few hours (Carr 1942). Most spawning appears to take place in late afternoon (Carr 1942; Chew 1974; Isaac *et al.* 1998). During prespawning, males leave the nest to locate and guide spawning-ready females back to the nest (Carr 1942). Once at the nest, the female, often much larger than the male, circles the nest with the male, during which time he gently nips and butts her head, tail, and sides to push her toward the nest. The male continues to swim actively around and to nip and hump the female; paired female and male circling can last for 10 to 20 or more minutes. The color pattern of both fish becomes more definite and vivid as they circle and enter the nest to spawn. The female then takes a position over the center of the nest, head downward and tilted slightly to the side. Ultimately, the male takes a position along the side of the female with their vents close, both shudder violently for about 10 seconds, including 15 to 20 jerks from side to side, and release eggs and milt. On spawning, the male inspects the nest, and after a 3- to 5-minute pause, the pair repeats the sequence of behaviors for another spawning episode. A pair may spawn for 2 to 4 hours and include 6 to 13 separate spawning acts, after which the female appears exhausted and has difficulty maintaining her position off the bottom (Carr 1942; Chew 1974; Isaac *et al.* 1998). In indoor raceways in which eggs were removed after each completed pairing, males participated in one to four separate spawning events during 8 days of observation (Isaac *et al.* 1998). Of 19 observed spawnings, only one female Florida bass spawned with each male, although females visited nesting sites of several males before spawning with a male (Isaac *et al.* 1998). On completion of spawning the male begins to energetically fan the eggs day and night, reducing or ceasing fanning activity when the eggs hatch. Mature ovarian eggs average 1.5 mm diameter, and fertilized eggs, 1.59 mm diameter (range, 1.49–1.67, Carr 1942; Chew 1974). Fecundity is apparently unquantified but is likely similar to the largemouth bass. The adhesive, orange-colored, fertilized eggs begin hatching in about 1.9 days at 22.2°C (Carr 1942; Chew 1974). Newly hatched, nearly transparent larvae are 3.4 mm TL, and depending on temperature, larvae are free swimming about 5 to 7 days after hatching at 6.5 to 7.2 mm TL. Male parental care from spawning through fry dispersal from the nest is 10 to 11 days (Carr 1942), but the time males spend guarding free-swimming juveniles is unknown. Biparental care is not documented in Florida bass, but observations of two individuals guarding a single nest for several days (Carr 1942; Miller 1975) are suggestive (e.g., DeWoody *et al.* 2000b).

Nest associates: Lake chubsucker, *E. sucetta* (Carr 1942); taillight shiner, *Notropis maculatus* (Chew 1974); golden shiner, *N. crysoleucas* (Chew 1974).

Freshwater mussel host: Confirmed host to *E. buckleyi*, *E. icterina*, *L. straminea claibornensis*, *L. siliquoidea*, *L. teres*, *M. nervosa*, *U. imbecilis*, *V. lienosa*, *V. iris* (reported as *V. nebulosa*) and *V. villosa* (Neves *et al.* 1985; Keller and Ruessler 1997, experimental hosts from hatchery stock were presumably Florida bass, A. E. Keller, U.S. Environmental Protection Agency, personal communication).

Conservation status: The Florida bass is secure throughout its range (Warren *et al.* 2000; NatureServe 2006).

Similar species: All other species of *Micropterus*, except the largemouth bass, have more confluent dorsal fins, upper jaws that reach to, or barely past, the center of the eye, and unbranched pyloric caeca. The largemouth bass, except in a broad area of intergradation in the southern United States, differs in usually having 59 to 66 lateral line scales and 26 to 28 scales around the caudal peduncle (Page and Burr 1991).

Systematic notes: *Micropterus floridanus* forms a sister pair with *M. salmoides* (Kassler *et al.* 2002; Near *et al.* 2003, 2004). Although long regarded as a subspecies of *M. salmoides*, nuclear-encoded allozyme loci, mitochondrial DNA, and nuclear DNA all indicate that *M. floridanus* is a distinct species (Philipp *et al.* 1983; Nedbal and Philipp 1994; Kassler *et al.* 2002; Near *et al.* 2003, 2004).

Importance to humans: The Florida bass and its sister species, the largemouth bass, are the core of the multibillion dollar black bass recreational fishery. The Florida bass is the most popular sport fish in Florida and its value as a sport fish in the state has prompted a movement toward increased management and catch-and-release fishing (FFWCC 2006). The large maximum size obtained by Florida bass in warm waters provides anglers with a real prospect of catching a trophy-sized black bass. In many Florida lakes and reservoirs anglers routinely catch Florida bass fish weighing 8 to 10 or more pounds (3.6 to 4.5 or more kilograms) (Crawford *et al.* 2002; FFWCC 2006). Although several studies suggest that Florida bass are more difficult to catch than the largemouth bass (Zolcynski and Davies 1976; Kleinsasser *et al.* 1990; Garrett 2002), the Florida bass will aggressively and explosively strike most kinds of artificial lures or live baits. Most individuals are taken on plastic worms, surface plugs, spinnerbaits, crankbaits, bass bugs, and minnows. The meat is white, flaky, and low in oil content (FFWCC 2006).

13.9.5 Micropterus notius *Bailey and Hubbs*

13.9.5.1 Suwannee bass

Characteristics: See generic account for general characteristics. Elongate, slightly compressed, but robust body, depth 0.26 to 0.27 of TL. Mouth large, terminal, lower jaw slightly projecting, upper jaw extends to posterior margin of eye in adults. Outline of spinous dorsal fin curved. Juncture of soft and spiny dorsal fins slightly emarginate, broadly connected. Shortest dorsal spine at emargination of fin, usually >0.6 times length of longest spine. Dorsal soft rays, 12 to 13; anal soft rays, 10 to 11. Gill rakers, usually 5. Relatively large scales. Lateral scales, 57 to 65; rows above lateral line, 6 to 9; rows below lateral line, 14 to 19; cheek scale rows, 9 to 15; caudal peduncle scale rows, 27 to 31; pectoral rays, (15)16(17). Small splintlike scales on interradial membranes at anal and second dorsal fin bases (>60 mm SL). Pyloric caeca single, rarely branched, 10 to 13. Tooth patch on glossohyal (tongue) bone (Bailey and Hubbs 1949; Ramsey and Smitherman 1972; Page and Burr 1991; Kassler *et al.* 2002).

Size and age: Size at age 1 ranges from 146 to 206 mm TL. Large individuals are >305 mm TL, weigh 400 g, and reach age 7+ (maximum 402 mm TL and age 9+ for males, age 12+ for females) (Bass and Hitt 1973; Page and Burr 1991; Cailteux *et al.* 2002; Bonvechio *et al.* 2005). World angling record, 1.75 kg, Florida (IGFA 2006). Females grow faster and live longer than males, and in a given population, 60% to 100% of individuals >305 mm TL are females (Bonvechio *et al.* 2005).

Coloration: Color similar to *M. salmoides* but usually brown overall, and sides marked with about 12 vertically elongate, lateral blotches. Blotches anteriorly are much wider than their interspaces, becoming more confluent with age. The blotches fuse on the caudal peduncle to form a relatively uniform, wide lateral band. Ventrolateral longitudinal streaks are weakly developed. Iris red. Young with a series of thin, closely spaced vertical bars along the sides of the body. Cheeks, breast, and lower sides colored brilliant turquoise blue in nesting males, less so in non-nesting individuals (Bailey and Hubbs 1949; Gilbert 1978; Page and Burr 1991).

Native range: The Suwannee bass is native to the Suwannee and Ochlockonee Rivers, Florida and Georgia (MacCrimmon and Robbins 1975; Page and Burr 1991). The provenance of populations in the Wacissa (Aucilla River drainage), Wakulla, and St. Marks rivers of Florida is uncertain (Koppelman and Garrett 2002; Cailteux *et al.* 2002; Bonvechio *et al.* 2005) but, given the lack of historical records, are likely introduced. Electrofishing catch data indicate that the species is most abundant in the Wacissa River (Aucilla River drainage) and Santa Fe River (Suwannee River drainage) (Schramm and Maceina 1986; Cailteux *et al.* 2002; Bonvechio *et al.* 2005).

Habitat: The Suwannee bass occurs in a variety of habitats in cool, clear, spring-fed rivers, which characteristically have limestone substrates (often covered with sand); alkaline, hard water; relatively stable thermal regimes; and dense submersed macrophyte beds (Bass and Hitt 1973; Gilbert 1978; Schramm and Maceina 1986; Cailteux *et al.* 2002). In the Santa Fe River, individuals (>150 mm TL) are associated with fallen trees over sandy substrate; shallow bedrock riffles (0.7–3.0 m deep); vegetated (eelgrass), gravel–sand riffles; deep vertical rock drop-offs (to 3 m); and shallow, sandy, gently sloping vegetated banks (0.5–1.0 m deep). Small individuals are most common around fallen trees but occur in a variety of flowing and nonflowing habitats (Schramm and Maceina 1986). Individuals also occupy spring runs of river tributaries where they seek cover under dense overhanging or floating vegetation (Gilbert 1978).

Food: The Suwannee bass is a top carnivore, extensively exploiting crayfishes for food. Crayfishes are the predominant food of individuals >150 mm TL, and for large fish (>300 mm TL), the diet is almost exclusively crayfishes. Fish rank second and freshwater shrimp third in importance in the diet; other crustacea, such as blue crabs, and a few aquatic insect larvae are also consumed. Juveniles (<150 mm TL) consume crayfish but also eat other invertebrates (grass shrimp, amphipods, aquatic insects) and some small fish (Bass and Hitt 1973; Gilbert 1978; Schramm and Maceina 1986; Cailteux *et al.* 2002). Size-adjusted throat width of the Suwannee bass is larger than that of Florida bass (or Florida × largemouth bass hybrids), allowing Suwannee bass (>167 mm TL) to consume larger prey items at a given size than the sympatric congener. Stomach contents of 142 Suwannee bass sampled in daylight hours from May to August revealed no obvious feeding periodicity (Schramm and Maceina 1986).

Reproduction: Size and age at maturity are not well documented, and little is published on reproductive behavior and biology of this unique, range-restricted *Micropterus*. Gonads of the sexes are distinguishable at minimum sizes of 125 mm SL in males and 142 mm SL in females, but the smallest females reported with mature ova are ≥215 mm SL (Bass and Hitt 1973). On the basis of female reproductive condition and other observations, spawning apparently begins in February or March as water temperatures reach 18 to 20°C and continues into June. Females with ripe ova are taken from February to May, spent females begin to appear in April with the largest numbers occurring in May. Suwannee bass nests in rivers have been noted in April, and spawning occurred in experimental ponds in Alabama in early April (Bailey and Hubbs 1949; Hellier 1967; Smitherman and Ramsey 1972; Bass and Hitt 1973). Young <25 mm TL are taken from April to July (Hellier 1967). Shallow circular depressions are excavated along stream edges "in typical sunfish fashion," and the male "guards the incubating ova" (Hurst *et al*. 1975) for an unspecified time. Fecundity increases with female size but is not well quantified. Estimated total ova of 18 gravid females (215–285 mm SL) ranged from 2520 to over 12,229 per individual and averaged 5397 (Bass and Hitt 1973). Fertilized eggs are 2.0 mm in diameter and hatch in about 3 to 4 days at 20°C. Yolk-sac larvae are 5.5 mm TL and reach 6.5 to 7.5 mm TL about 6 days after hatching (presumably swim-up stage) (Smitherman and Ramsey 1972).

Nest associates: None known.

Freshwater mussel host: Confirmed host to *V. iris* (reported as *V. nebulosa*, Neves *et al*. 1985).

Conservation status: Because of its restricted range, the Suwannee bass is regarded as vulnerable throughout its native range (Warren *et al*. 2000; Koppelman and Garrett 2002) and is considered imperiled in Georgia and vulnerable in Florida (NatureServe 2006). Nevertheless, the species does not appear to have experienced declines in abundance or distribution in historical times (e.g., Santa Fe River, Bass and Hitt 1973; Bass 1974; Schramm and Maceina 1986; Bonvechio *et al*. 2005). Moreover, the present range includes more independent river systems than were known historically, and some of these rivers support high abundances of the species (Cailteux *et al*. 2002; Bonvechio *et al*. 2005).

Similar species: The largemouth bass and the Florida bass have a deep notch between the spiny and soft dorsal fins, and the pyloric caeca are branched (Page and Burr 1991). Young Suwannee bass have closely spaced, elongate vertical bars along the sides of the body (versus solid longitudinal stripe in young largemouth bass and Florida bass) (Gilbert 1978).

Systematic notes: *Micropterus notius* is a member of a "Gulf of Mexico" clade of *Micropterus*, including all other *Micropterus* except *M. dolomieu* and *M. punctulatus* (Kassler *et al*. 2002; Near *et al*. 2003, 2004). Relationships within the clade are not well resolved, with *M. notius* placed as basal to the entire clade, sister to *M. cataractae*, or sister to *M. treculi* and *M. salmoides* × *M. floridanus* (Kassler *et al*. 2002; Near *et al*. 2003, 2004). Similarities in form and color led most morphological taxonomists to relate *M. notius* to *M. punctulatus* (e.g., Bailey and Hubbs 1949; Ramsey 1975).

Importance to humans: Decades before its scientific description, the Suwannee bass was recognized as unique and sought by local Florida anglers, who knew where and how to fish for the species (Swift *et al*. 1977). Even though relatively small, Suwannee bass are regarded as strong fighters when caught on light tackle. Individuals are taken on small crayfish-colored spinnerbaits, crankbaits, plastic worms, and jigs and live baits (e.g., dobsonfly larvae, crayfish). A limited, but specialty, black bass fishery exists in the lower Santa Fe River where Suwannee bass provide a small portion of the sport fish catch (dominated by redbreast sunfish) but constitute over a third of the total catch of *Micropterus* (Bass and Hitt 1973). In the crystal clear, flowing waters of the Wacissa River, float fishers, using light fly fishing gear and wet flies mimicking bait fish, regard the Suwannee bass as a challenging catch in an exceptionally high-quality environment (Ferrin 2006). The meat is reportedly white, flaky, and flavorful (FFWCC 2006).

13.9.6 Micropterus punctulatus *(Rafinesque)*

13.9.6.1 Spotted bass

Characteristics: See generic account for general characteristics. Elongate, slightly compressed body, depth 0.17 to 0.27 of TL, increasing with size. Mouth large, terminal, lower jaw slightly projecting, upper jaw extends little or not at all beyond posterior edge of eye. Outline of spinous dorsal fin curved. Juncture of soft and spiny dorsal fins slightly emarginate, broadly connected. Shortest dorsal spine at emargination of fin, usually 0.4 to 0.9 times the length of longest spine. Dorsal soft rays, usually 12 or 13, 11 to 14; anal soft rays, usually 10, 9 to 11. Gill rakers, 5 to 7. Lateral scales, (55)60 to 75(79); rows above lateral line, (6)7 to 9(11); rows below lateral line, (11)13 to 18(22); cheek scale rows, (10)13 to 18(20); caudal peduncle scale rows, (21)25 to 31(32); pectoral rays, (13)15 to 17(18). Small splintlike scales on interradial membranes at anal and second dorsal fin bases (>60 mm SL). Pyloric caeca, single, rarely branched, 10 to 13. Tooth patch present on glossohyal (tongue) bone (Hubbs 1927; Hubbs and Bailey 1940, 1942; Applegate 1966; Bryan 1969; Ramsey and Smitherman 1972; Williams and Burgess 1999).

Size and age: Size at age 1 averages about 113 mm TL but varies considerably among habitats and across the geographic range (population averages range from 66 to 216 mm TL) (Vogele 1975b; Webb and Reeves 1975; Carlander 1977; Olmsted and Kilambi 1978; DiCenzo *et al.* 1995; Pflieger 1997; Maceina and Bayne 2001). Growth rate trends higher in reservoirs than in streams (Vogele 1975b), and the Alabama spotted bass, *M. p. henshalli*, lives longer and reaches a larger size than the northern subspecies, *M. p. punctulatus* (DiCenzo *et al.* 1995). However, the Alabama spotted bass may represent a distinct taxon and perhaps be only distantly related to *M. punctulatus* (e.g., Kassler *et al.* 2002). Few individuals exceed 425 mm TL, 2.0 kg, and ages 6+ (maximum about 640 mm TL and age 11+) (Gilbert 1973; Webb and Reeves 1975; Carlander 1977; Olmsted and Kilambi 1978; Page and Burr 1991; DiCenzo *et al.* 1995; Wiens *et al.* 1996; Maceina and Bayne 2001). World angling record, 4.65 kg, California (IGFA 2006). Females of the Alabama spotted bass, *M. p. henshalli*, and perhaps other spotted bass populations (e.g., Ryan *et al.* 1970), can live longer than males (age 8+ versus age 5+) and after the third year show faster growth and weigh more than males (Webb and Reeves 1975).

Coloration: Rows of small black spots on yellow-white lower sides form horizontal lines. Dark midlateral stripe or series of partly joined blotches along light olive to yellowish green side. Caudal spot dark, darkest on young. Light green-gold dorsally with dark olive, often diamond-shaped mottlings. Young (<50 mm TL) with distinct tricolored caudal fin markings (yellowish base, dark middle, whitish edge) (Trautman 1981; Page and Burr 1991).

Native range: The spotted bass is native to the Mississippi River basin from southern Ohio and West Virginia to southeastern Kansas and south to the Gulf and in Gulf drainages from the Choctawhatchee River, Alabama and Florida, west to the Guadalupe River, Texas (Robbins and MacCrimmon 1974; Page and Burr 1991; Miller 2005). Populations in the Apalachicola River Basin were likely introduced (Bailey and Hubbs 1949; Williams and Burgess 1999). The spotted bass was widely introduced and is established outside its native range across most of the southern half of the western United States and in some river systems has rapidly expanded its range after introduction (e.g., Missouri River) (Robbins and MacCrimmon 1974; Pflieger 1997; Fuller *et al.* 1999; Moyle 2002). Hybridization and introgression can be extensive when nonnative *M. punctulatus* are introduced into native populations of *M. dolomieu* (Koppelman 1994; Pierce and Van Den Avyle 1997; Avise *et al.* 1997). Data from nuclear-encoded allozymes and mitochondrial DNA haplotypes revealed a remarkable pattern of faunal turnover and introgressive swamping of the native *M. dolomieu* by the nonnative *M. punctulatus* in a northeastern Georgia reservoir (Hiwassee River drainage, Avise *et al.* 1997). In only 10 to 15 years after the introduction of *M. punctulatus*, the *M. dolomieu* population declined dramatically. Even more surprising was the finding that >95% of remaining *M. dolomieu* mtDNA haplotypes (and nuclear alleles) in the lake population were found in fishes of hybrid ancestry between the introduced and native *Micropterus*. Similar patterns indicative of introgressive swamping occurred when *M. punctulatus* was introduced into a native population of *M. dolomieu* in South Moreau Creek (Missouri River drainage), Missouri (Koppelman 1994), and are suggested for introductions of *M. p. henshalli* into a native population of *M. coosae* in Keowee Reservoir (Savannah River drainage), South Carolina (Barwick *et al.* 2006).

Habitat: The spotted bass inhabits gravelly flowing pools and runs of creeks and small to medium rivers and reservoirs (Page and Burr 1991). In streams, spotted bass are commonly associated with low-velocity pools, particularly those with vegetation, log complexes, rootwads, or undercut banks (Lobb and Orth 1991; Scott and Angermeier 1998; Tillma *et al.* 1998; Horton and Guy 2002; Horton *et al.* 2004). The habitat requirements of the species can be broadly characterized as intermediate between those of the smallmouth bass and largemouth bass. The spotted bass is associated with warmer, more turbid water than smallmouth bass, and faster, less productive waters than the largemouth bass (Trautman 1981; Layher *et al.* 1987; Pflieger 1997). Nevertheless, spotted bass frequently co-occur with largemouth bass, smallmouth bass, and redeye bass but generally show some spatial segregation from co-occurring *Micropterus*, in cover type, longitudinal distribution, or water depth (e.g., Viosca 1931; Vogele 1975b; Trautman 1981; Buynak *et al*. 1989; Matthews *et al*. 1992; Pflieger 1997; Scott and Angermeier 1998; Sammons and Bettoli 1999; Long and Fisher 2005). For example, spotted bass were widely distributed in a Virginia impoundment, but occurred most commonly in areas with fine substrate and woody debris, undercut banks, and bank vegetation as cover, avoiding the steep drop-offs and rocky shorelines frequented by smallmouth bass (Scott and Angermeier 1998). In southern US reservoirs, spotted bass are most abundant in oligo-mesotrophic reservoirs or oligo-mesotrophic reaches of reservoirs with abundance decreasing as eutrophication increases; an opposite pattern occurs for largemouth bass abundance (Buynak *et al*. 1989; Greene and Maceina 2000; Maceina and Bayne 2001). Although spotted bass may enter relatively high-salinity coastal environments ($\leq$10 ppt), they infrequently occur in coastal marshes with salinities >4 ppt (Peterson 1988, 1991; Peterson and Ross 1991).

Relatively little is known about movements of spotted bass. In some populations, indirect evidence suggests massive upstream movement in spring from reservoirs and rivers into tributaries to spawn, followed by a gradual downstream drift of most adults and young to overwinter in large, lower-gradient habitats (Vogele 1975b; Trautman 1981). The average home activity area of radio-tagged spotted bass tracked over multiple seasons in a Kansas stream was 0.39 ha (range, 0.06–1.2 ha). Activity area was correlated positively with body size, and activity areas of up to six fish showed simultaneous overlap. During summer and winter, fish typically remained in one pool, but during spring and fall, fish crossed riffles and moved among pools (Horton and Guy 2002).

Food: The spotted bass is an opportunistic carnivore, exploiting prey from the bottom to the water's surface. The adult diet is dominated in biomass by crayfish if present, fish (e.g., clupeids, darters, minnows, catfishes), and to a lesser extent, immature aquatic insects (Applegate *et al*. 1967; Gilbert 1973; Vogele 1975b; Scott and Angermeier 1998). Depending on prey availability, consumption of large numbers and volumes of immature aquatic insects may continue up to 150 mm TL or larger. Spotted bass may exploit relatively large numbers and volumes of terrestrial insects (e.g., hymenoptera, beetles, flies, adult odonates) (Smith and Page 1969; Ryan *et al*. 1970; Vogele 1975a; Scott and Angermeier 1998). The young initially depend on zooplankton (cladocerans and copepods) with juveniles transitioning from large immature aquatic (e.g., mayflies, diptera) insects to fish and crayfish at 50 to 100 mm TL (Applegate *et al*. 1967; Clady and Luker 1982; Matthews *et al*. 1992; Scott and Angermeier 1998). Spotted bass are relatively inactive at night, staying close to cover, but move frequently throughout the day (Horton *et al*. 2004). Even so, diet data reveal no clear diel feeding patterns except for an increase in terrestrial insects in the diet during the day (Scott and Angermeier 1998).

Reproduction: Maturity can be reached as early as age 1+ in fast-growing populations, but most individuals do not mature until age 2+ to 3+ (Gilbert 1973; Olmsted 1974; Vogele 1975a,b). Depending in part on latitude and water temperature, spawning occurs over a 1- to 2-month period from March to May or early June, with the most intensive nesting occurring within about 2 weeks of initial spawning activity (Ryan *et al*. 1970; Gilbert 1973; Olmsted 1974; Vogele 1975a; Sammons *et al*. 1999; Greene and Maceina 2000). Active nests have been observed at temperatures as low as 12.8°C, but most spawning occurs between 14°C and 23°C (Howland 1932a; Ryan *et al*. 1970; Smitherman and Ramsey 1972; Gilbert 1973; Olmsted 1974; Vogele 1975a,b; Aasen and Henry 1981; Sammons *et al*. 1999). The male excavates a solitary, depressional, roughly circular nest by caudal sweeping and removing material with his mouth (Breder and Rosen 1966); nests are spaced widely with densities ranging from 0.5 to 11.3/100 m of shoreline. Most but not all nests are located near cover (e.g., rock overhangs, stumps, submerged tree bases) (Vogele 1975a; Vogele and Rainwater 1975). Nests are 38 to 76 cm in diameter, are located at average water depths of 2.3 to 3.7 m (range, 0.9–6.7 m), and are usually swept out over hard substrates (e.g., sand and gravel, solid rock ledges, flat rocks), but compacted soil and exposed root hairs of flooded trees are also used (Vogele 1975a,b; Aasen and Henry 1981). Males may excavate and defend one to four nest sites for up to 3 days before egg deposition. Limited evidence from tagged males suggests year-to-year fidelity to specific nesting areas (Vogele 1975a). Courtship and spawning are generally typical of other *Micropterus*, but published documentation is not extensive (e.g., male guiding of female, paired circling) (Miller 1975; Vogele 1975a,b, citing Howland 1932b). Once a female is attracted to the nest, the male guides her in circles about the nest (female inside, male outside), repeatedly biting at her opercle and vent. During courtship, the midlateral stripe in the female disappears (Miller 1975). Courtship behaviors continue for 20 minutes to 1 hour before egg deposition begins. Ultimately, the female deposits eggs (for 1.5 to 5 seconds) by tilting on her side, and the male releases milt in an upright position as is typical for most centrarchids. Courtship and spawning sequences between pairs may require up to 3.5 hours for completion (Vogele 1975a). Most spawning observations involved a single male and female. After spawning, males immediately begin fanning the eggs and continue defending the eggs from numerous, persistent *Lepomis* and other predators (Vogele 1975a). Mature ovarian eggs range from 1.30 to 2.20 mm diameter (Gilbert

1973; Vogele 1975a) and fertilized, water-hardened eggs range from 1.60 to 2.30 mm diameter (Smitherman and Ramsey 1972; Vogele 1975a). Fecundity increases with female size. The relationship between potential batch fecundity (Y) and total length (X) is described by the function, $\log_{10} Y = -8.222 + 4.779 \log_{10} X (n = 48, R^2 = 0.71)$, data from Olmsted 1974 and Vogele 1975a). At 347 mm TL, a female can potentially produce 8284 mature eggs in a single batch (range: 1728 eggs at 250 mm TL to 26,906 eggs at 444 mm TL, respectively). The adhesive, fertilized eggs hatch in 5 days at 14.4°C to 15.6°C (Vogele 1975a). Larvae are free swimming at 6.0 to 7.5 mm TL in 4 days and 8 days after hatching at 25°C and 15 to 18°C, respectively (Vogele 1975a; DiCenzo and Bettoli 1995). Fry emerging from the nest form compact schools that are guarded by the parental male for up to 4 weeks. Schools with fry from different nests may merge into a single large school and be guarded by two parental males. The schools break up as fry reach about 30 mm TL (Vogele 1975a). In hatchery ponds, males apparently exhibited less parental care, abandoning the fry shortly after swim-up (Smitherman and Ramsey 1972; Vogele 1975b).

Nest associates: None known.

Freshwater mussel host: Confirmed host to *L. altilis, L. perovalis, Lampsilis subangulata, V. iris, V. nebulosa,* and *V. vibex* (Neves *et al.* 1985; Haag and Warren 1997; Haag *et al.* 1999; O'Brien and Brim Box 1999). Putative host to *L. abrupta* (unpublished sources in OSUDM 2006).

Conservation status: The spotted bass is secure throughout its range, but peripheral populations in Illinois are considered vulnerable (Warren *et al.* 2000; NatureServe 2006). Lack of resolution of the genetic relationships among populations now regarded as *M. punctulatus* is of primary conservation concern (Kassler *et al.* 2002; see section on systematic notes).

Similar species: Shoal bass has dark vertically elongate bars on sides and lacks patch of teeth on tongue; redeye bass has white to orange upper and lower edges on caudal fin lobes and young has red medial fins; largemouth bass and Florida bass lack rows of black spots on lower sides and have a deep notch between spiny and soft dorsal fins; young of these species have a bicolored caudal fin (white, black edge); smallmouth bass lacks a distinct lateral stripe (Page and Burr 1991).

Systematic notes: *Micropterus punctulatus* and *M. dolomieu* form a sister pair that is basal to all other *Micropterus* (Kassler *et al.* 2002; Near *et al.* 2003, 2004, 2005). As currently conceived, the long-presumed polytypy of *M. punctulatus* (Hubbs and Bailey 1940) appears to subsume two relatively distantly related and divergent species of *Micropterus*. Morphological and genetic data indicate that a small-scaled form, the Alabama spotted bass (nominal *M. p. henshalli*), occurs in Mobile Basin (Hubbs and Bailey 1940; Gilbert 1973; Kassler *et al.* 2002). Although intergrades between *M. p. punctulatus* and *M. p. henshalli* were suggested from limited samples from west of Mobile Basin to the Lake Pontchartrain system (Hubbs and Bailey 1940), more extensive meristic data revealed no evidence of intergradation in that region (Gilbert 1973). However, individuals above the Fall Line in Mobile Basin were assigned to *M. p. henshalli* and those below the Fall Line were interpreted as intergrades between *M. p. henshalli* and *M. p. punctulatus* (Gilbert 1973). The putative intergrades could just as easily represent *in situ* differentiation of quasi-isolated populations of Alabama spotted bass, rather than intergradation. Importantly, mitochondrial DNA analyses from limited population sampling indicate that the form in Mobile Basin is highly divergent from *M. p. punctulatus* (e.g., fixed allelic differences at multiple gene loci, fixed haplotype differences, sequence divergence of 10.3%) and is genetically most similar to *M. coosae* (Kassler *et al.* 2002). Unfortunately, *M. p. henshalli* has been introduced outside the native range in Mobile Basin and has introgressed with native *Micropterus* (Pierce and Van Den Avyle 1997). The resolution of the relationships of the Alabama spotted bass to other *Micropterus* awaits a thorough genetic analysis across populations in the Mobile Basin. The subspecies *M. p. wichitae*, ostensibly restricted to a single stream in the Red River drainage, Oklahoma (Hubbs and Bailey 1940), was based on *M. punctulatus* × *M. dolomieu* hybrids and is not valid (Cofer 1995). The subspecies *M. p. punctulatus* occupies the remainder of the range (Gilbert 1973).

Importance to humans: Ecologically, the spotted bass can function as the only top carnivore in small, even intermittent, headwater streams and is often the dominant top predator in large rivers and reservoirs (Cross 1967; Trautman 1981; Pflieger 1997). The spotted bass is also a popular sport fish in streams and reservoirs throughout the southeastern United States. The species is sought in streams by anglers favoring fly fishing or ultralight tackle (Cross 1967; Ross 2001). The largest spotted bass are taken in reservoirs and spillways where food availability is higher than in most streams (Ross

2001). In southern US reservoirs, spotted bass can be the dominant or co-dominant *Micropterus* and constitutes a sizable proportion of the black bass catch (e.g., 60%) and harvest (e.g., 50%) (Webb and Reeves 1975; Novinger 1987; Buynak *et al*. 1989, 1991; DiCenzo *et al*. 1995; Pflieger 1997; Sammons *et al*. 1999; Sammons and Bettoli 1999; Long and Fisher 2005). The spotted bass often co-occurs with the largemouth bass or smallmouth bass in reservoirs, where most management effort is usually focused on the latter two species (e.g., Maceina and Bayne 2001; Long and Fisher 2005). Because of its slower growth and high abundance in some reservoirs, fishery managers combine liberalized harvest of spotted bass with increased length limits for largemouth bass (or smallmouth bass) to reduce exploitation and to increase the size of the latter (e.g., Buynak *et al*. 1991; Long and Fisher 2005). The spotted bass takes the same lures (e.g., spinner baits, plastic worms, jigs, crank baits) and live baits (e.g., minnows, crayfishes, salamanders) as other black bass. Anglers consider their strike more aggressive and their fight more spirited than that of the largemouth bass (Ross 2001).

13.9.7 Micropterus salmoides *Lacépède*

13.9.7.1 Largemouth bass

Characteristics: See generic account for general characteristics. Elongate, slightly compressed body, depth 0.24 to 0.29 of TL, increasing with size. Mouth large, terminal, lower jaw slightly projecting, upper jaw extends beyond posterior edge of eye in adults. Outline of spiny dorsal fin sharply angular. Juncture of soft and spiny dorsal fins deeply emarginate, almost separate. Shortest dorsal spine at emargination of fin, usually 0.3 to 0.4 times length of longest spine, membranes between short spines deeply incised. Dorsal soft rays, usually 13 or 14, 11 to 15; anal soft rays, usually 11 or 12, 10 to 14. Gill rakers, 7 to 9. Lateral scales, (55)58 to 67(72); rows above lateral line, 7 to 8(9); rows below lateral line, 13 to 17; cheek scale rows, 9 to 11(13); caudal peduncle scale rows, (24)26 to 28(30); pectoral rays, (13)14 to 15(17). No small splintlike scales on interradial membranes at anal and second dorsal fin bases. Pyloric caeca branched at base, 12 to 45. Tooth patch usually absent on glossohyal (tongue) bone, but tooth patch present or absent in San Antonio and Nueces rivers, southwest Texas, and present in $\geq$50% of specimens in the Rio Grande system, Mexico and Texas (Hubbs and Bailey 1940; Bailey and Hubbs 1949; Applegate 1966; Keast and Webb 1966; Buchanan 1973; Chew 1974; Edwards 1980; Kassler *et al*. 2002).

Size and age: Size at age 1 is highly variable among habitats and across latitudes, ranging from 33 to 271 mm TL (median 102 mm TL) (Carlander 1977; McCauley and Kilgour 1990; Beamesderfer and North 1995; Garvey *et al*. 2003). Critical periods causing differential size, growth, and survival for age-0 cohorts include time of hatching, onset of piscivory, accumulation of lipids in the fall, and the ability to survive predation, starvation, or both over the first winter (DeAngelis and Coutant 1982; Gutreuter and Anderson 1985; Miranda and Hubbard 1994a,b; Ludsin and DeVries 1997; Maceina and Bettoli 1998; Garvey *et al*. 1998; Post *et al*. 1998; Fullerton *et al*. 2000; Garvey *et al*. 2000, 2002; see section on habitat). Large individuals can exceed 550 mm TL, weigh >3.5 kg, and attain age 8+ to 15+ (Carlander 1977; Beamesderfer and North 1995). The oldest largemouth bass and longest-lived *Micropterus* is a 23- or 24-year-old individual (584 mm TL) from New York (Green and Heidinger 1994). The world angling record for all *Micropterus* (and all centrarchids) is a largemouth bass weighing 10.1 kg (~ 787 mm TL) that was caught in Georgia in 1932 (IGFA 2006). At least in some populations, older females (age 4+) are longer than males, and most older individuals are females (Webb and Reeves 1975; Carlander 1977).

Coloration: Broad olive or olive black midlateral stripe formed of confluent or nearly confluent blotches. Silver to brassy green (brownish in tea-stained water) above with dark olive mottling. Scattered dark specks on lower sides; whitish below. Iris brown. Young (<50 mm TL) with bicolored caudal fin markings (whitish base, dark distally) (Bailey and Hubbs 1949; Page and Burr 1991; Etnier and Starnes 1993; Jenkins and Burkhead 1994).

Native range: The largemouth bass is native to the St. Lawrence-Great Lakes, Hudson Bay (Red River), and Mississippi River basins from southern Quebec to Minnesota and south to the Gulf of Mexico and in Gulf drainages from about Mississippi or Alabama west to the Rio Grande and Soto la Marina in northeastern Mexico (Page and Burr 1991; Miller 2005). On the Atlantic Slope, early introductions of "largemouth bass" in many drainages obscured the northern limit of the native range (Jenkins and Burkhead 1994). Critical evaluation of early records and reports and evaluation of nuclear-encoded allozyme data across Virginia suggests that the species occurred historically on the Atlantic Slope to the Tar

River of North Carolina but not beyond (Jenkins and Burkhead 1994; Dutton *et al.* 2005). A broad area of hybridization between the largemouth bass and the Florida bass occurs across the southeastern United States. Before extensive stocking of Florida bass into the range of the largemouth bass, meristic variation indicated a relatively narrow hybrid zone between the two species from the Savannah River south to the St. Mary's River on the Atlantic Slope and from the Choctawhatchee and St. Andrews bays east to the Suwannee River on the Gulf Slope (Bailey and Hubbs 1949). Genetic data incorporating many reservoir and a few riverine populations prescribe a broader area of hybridization, extending from at least central Texas eastward across parts of Louisiana and Arkansas, and most of Mississippi, Alabama, northern Florida, Georgia, and well northward on the Atlantic Slope to Virginia and Maryland. The large extent of the hybrid zone is primarily the result of repeated, deliberate introductions of Florida bass into the range of the largemouth bass, but the extent of natural, isolated populations of pure *M. salmoides* within this broad hybrid zone is uncertain (Philipp *et al.* 1981, 1983; Maceina *et al.* 1988; Morizot *et al.* 1991; Philipp 1991; Dunham *et al.* 1992; Brown and Murphy 1994; Bulak *et al.* 1995; *et al.*Gelwick *et al.* 1995; Whitmore and Craft 1996; Dutton *et al.* 2005; Lutz-Carillo *et al.* 2006). The largemouth bass, its sister species, the Florida bass, or genetic admixtures of the two species have been introduced and are established in much of North America from southern Canada to Mexico. The species is also established in the Caribbean, Oceania, Asia, Africa, Europe, and South America (Robbins and MacCrimmon 1974; Holčík 1991; Fuller *et al.* 1999). The largemouth bass is one of eight fishes included in the top 100 of the world's worst invasive alien species (Cambray 2003) because of its negative effects on native fishes and ability to literally change ecosystem function (e.g., Whittier *et al.* 1997; Rahel 2000; Skelton 2000; Findlay *et al.* 2000; Gratwicke and Marshall 2001; Jackson 2002; Moyle 2002).

Habitat: The largemouth bass inhabits lakes, ponds, swamps, marshes, and backwaters and pools of creeks, and small to large rivers as well as impoundments (Page and Burr 1991). Generally, the largemouth bass is adapted to warmer, more eutrophic waters than other *Micropterus*, except the Florida bass. Even so, the largemouth bass frequently co-occurs with other black basses, but in those cases the *Micropterus* assemblage often shows shifts in species-relative abundances among mesohabitats (e.g., Rutherford *et al.* 2001, see accounts on *M. dolomieu* and *M. punctulatus*). The species occurs and often thrives in an array of lacustrine habitats including saline marshes along the Gulf of Mexico and Atlantic Coast (Peterson and Meador 1994); bottomland hardwood swamps and associated floodplain lakes (Rutherford *et al.* 2001); and vegetated glacial lakes (Werner *et al.* 1977). Over its broad range, the species tends toward highest abundance in warm eutrophic, vegetated reservoirs or the most eutrophic sections within a reservoir (Robbins and MacCrimmon 1974; Durocher *et al.* 1984; Buynak *et al.* 1989; Maceina and Bettoli 1998; Allen 1999; Allen *et al.* 1999; Greene and Maceina 2000; Maceina and Bayne 2001; Brown and Maceina 2002). In swamps, lakes, and reservoirs, young and adult largemouth bass are associated with shallow shorelines (usually <3 m deep) around aquatic macrophyte beds, logs, or other cover, but the young use gravel substrates and steep shoreline slopes if vegetation or other cover is not present (e.g., Werner *et al.* 1977; Schlagenhaft and Murphy 1985; Matthews *et al.* 1992; Annett *et al.* 1996; Demers *et al.* 1996; Hayse and Wissing 1996; Irwin *et al.* 1997, 2002; Miranda and Pugh 1997; Essington and Kitchell 1999; Sammons and Bettoli 1999; Irwin and Noble 2000; Rutherford *et al.* 2001; Olson *et al.* 2003). Young largemouth bass in lakes and reservoirs move inshore at night and offshore during the day; such diel movement is lessened if inshore cover is present (Werner *et al.* 1977; Irwin and Noble 2000). In riverine habits, both young and adult largemouth bass occupy a variety of habitats but are most common in deep pools or low-velocity habitats near undercut banks, instream wood, overhanging and aquatic vegetation, or other cover (e.g., Killgore *et al.* 1989; Sowa and Rabeni 1995; LaPointe *et al.* 2007).

The physical habitat needs, environmental tolerances, and spatial ecology of nearly all life stages of the largemouth bass, particularly for populations in reservoirs, are one of the most well studied of any fish species in North America, being rivaled only by some salmonids (e.g., rainbow trout) and the bluegill. Here, the focus is to briefly introduce aspects of largemouth bass movement in lakes and rivers, relate some broad effects of temperature, and highlight tolerances to salinity, hypoxia, and pH. These and other habitat-associated topics on largemouth bass are available in the references cited in this account and many other sources (e.g., Dahlberg *et al.* 1968; Glass 1968; Beamish 1970; Aggus and Elliot 1975; Coutant 1975; Heidinger 1975; Siler and Clugston 1975; Farlinger and Beamish 1977; Bennett 1979; McCormick and Wegner 1981; Lemons and Cranshaw 1985; Fields *et al.* 1987; Johnson *et al.* 1988; Koppelman *et al.* 1988; Kolok 1991, 1992; Smale and Rabeni 1995b; Raibley *et al.* 1997b; Miranda and Dibble 2002; Parkos and Wahl 2002).

The largemouth bass exhibits directed movement (homing) over relatively long distances, movement to and from wintering (and spawning) areas, and persistent association with home activity areas over long periods. Movement is related to water temperature with activity generally being lowest at temperature extremes of midsummer and midwinter (Warden and Lorio 1975; Carlson 1992; Nack *et al.* 1993; Richardson-Heft *et al.* 2000; Karchesky and Bennett 2004; Hasler *et al.* 2007). During winter in an iced-over northern lake, acoustically tagged largemouth bass stayed in a deep basin in the lake, but moved in spring to a shallow basin (Hasler *et al.* 2007). In both seasons bass formed multi-individual aggregations (individuals <2 m apart) during the day. Aggregations, especially in winter, lasted for several hours a day, and male–female associations were greater than expected by chance (Hasler *et al.* 2007). Tracking studies suggest that largemouth bass, when moving from one activity area to another, travel along the deepest bottom contours (e.g., submerged creek channels) in shallow lacustrine habitats or in the low-velocity currents along shorelines in flowing rivers (Warden and Lorio 1975; Karchesky and Bennett 2004). In displacement studies, about 26% to 43% of individuals return to their original place of capture; some individuals require months to return and others a few days even if displacement distances are similar (Parker and Hasler 1959; Stang *et al.* 1996; Richardson-Heft *et al.* 2000; Ridgway 2002; Wilde 2003). Many individuals displaced in the upper Chesapeake Bay traveled at least 15 to 21 km across the bay to return to their original place of capture, although return times tended to take longer in fall (228 days) than in spring (65 days) (Richardson-Heft *et al.* 2000). In the same study, mean daily movement of 78 displaced radio-tagged largemouth bass was up to 1.45 km/d and maximal movement was 8.37 km/d. Other studies of the species document even longer distance movements (16–64 km) to consistently used winter refuges (or spawning areas) to avoid extreme flows, wave action, and temperature conditions (Funk 1957; Raibley *et al.* 1997a; Nack *et al.* 1993; Gent *et al.* 1995; Irwin *et al.* 2002; Karchesky and Bennett 2004). Postspawning summer and fall home range areas of largemouth bass in an Ontario lake averaged 16.7 to 17.6 ha (Ridgway 2002). Studies of riverine or other lake-dwelling populations generally reveal high persistence (8–110 days) in even smaller areas (150 linear stream meters, 0.18–3.0 ha). However, movements out of these high-use areas for extended periods, movements among high-use areas, and extensive ostensibly random movements without establishment of apparent activity areas are also common (e.g., Lewis and Flickinger 1967; Warden and Lorio 1975; Winter 1977; Savitz *et al.* 1983, 1993; Meador and Kelso 1989; Bain and Boltz 1992; Gatz and Adams 1994; Rogers and Bergersen 1995; Demers *et al.* 1996; Essington and Kitchell 1999; Karchesky and Bennett 2004).

Temperature exerts considerable influence on largemouth bass populations across the broad band of latitude comprising the total range of the species. The species has a relatively high critical thermal maxima of 38.5 to 40.9°C (acclimated at >30°C, Smith and Scott 1975; Fields *et al.* 1987; Beitinger *et al.* 2000; Currie *et al.* 1998, 2004), so that high temperatures are not particularly limiting. In contrast, the summer thermal regime or, alternatively, the duration and severity of winters profoundly affect the distribution, growth, and survival of largemouth bass. In a synthesis of growth data across North America (from Carlander 1977), over half the latitudinal variation in growth (size at age) for largemouth bass (including Florida bass) was accounted for by differences in monthly mean air temperatures (degree days >10°C) across a north–south latitudinal gradient (McCauley and Kilgour 1990). The northern distributional limit for the largemouth bass was estimated as a thermal unit isocline of 550 degree days above 10°C in extreme southern Canada. In a model incorporating data for largemouth bass populations across North America (again including a few Florida bass), age to reach 300 mm TL was correlated negatively with mean air temperature (also degree days >10°C and latitude), and instantaneous natural mortality rate was correlated positively with mean air temperature (Beamesderfer and North 1995). Likewise, average length by fall of age-0 largemouth bass is related positively to latitude and presumably temperature (Garvey *et al.* 2003). Temperature effects are directly or indirectly related to several critical events in the first year of life including hatch date, length of growing season, transition to piscivory, fall lipid accumulation, winter food availability, and the duration and severity of winter (Kramer and Smith 1960a, 1962; Adams *et al.* 1982a,b; Isely *et al.* 1987; Miranda and Hubbard 1994a,b; Ludsin and DeVries 1997; Post *et al.* 1998; Wright *et al.* 1999; Fullerton *et al.* 2000; Jackson and Noble 2000; Fuhr *et al.* 2002; Philipp *et al.* 2002). For age-0 fish, winter is often a huge survival bottleneck because of complex interactions of winter severity, food availability, and predation. When water temperatures are <6°C for extended periods, feeding is stopped or is infrequent and small individuals experience greater proportional energy loss and increased mortality relative to large individuals (Garvey *et al.* 1998). If low temperature conditions are prolonged, energy reserves built up in summer and fall can be depleted in small individuals regardless of winter food availability (Wright *et al.* 1999). Under less severe winter conditions, warm or fluctuating winter temperatures may exacerbate metabolic costs of young fish during a period of reduced food availability (e.g., fish prey too large) and increased predation risk (Ludsin and DeVries 1997). Common garden and winter simulation experiments measuring differential growth and survival among largemouth bass from different latitudes provide compelling evidence of genetic adaptation to local temperature regimes (and other local environmental factors). When stocks of largemouth bass from Wisconsin, Illinois, and Texas were compared in common garden experiments, the local native stock consistently had higher growth, survival, and reproductive fitness than transplanted nonnative stocks (Philipp *et al.* 2002). In laboratory experiments, 92% to 100% of age-0 largemouth bass from Alabama died when subjected to simulated temperatures, lengths, and photoperiods of an intermediate (Ohio) and long (Wisconsin) winter, but similar-sized Ohio and Wisconsin stocks survived a simulated Alabama winter. Energy depletion measured as weight loss showed a gradient with fed individuals from all three sources maintaining or gaining weight under the Alabama winter, maintaining weight under the Ohio winter, and losing weight under the Wisconsin winter. Winter survival was also size mediated with small fish suffering higher mortality than large fish under both the Alabama and Wisconsin winters (Wright *et al.* 1999; Fullerton *et al.* 2000), results consistent with experimental studies in ponds and empirical observations in reservoirs (Miranda and Hubbard 1994a; Ludsin and DeVries 1997).

Coastal populations of largemouth bass frequent oligohaline marsh systems along the Atlantic and Gulf coasts. These populations are at least moderately tolerant of prolonged saline conditions (usually <8 ppt) and show differences in salinity selection, physiology, and growth relative to freshwater populations (Meador and Kelso 1990a,b; Peterson 1991; Peterson and Ross 1991; Peterson and Meador 1994; Krause 2002; Peer *et al.* 2006). Effects of <4 ppt salinity on blood plasma level concentrations in adult coastal marsh and freshwater largemouth bass populations in Louisiana are minimal, and acclimation does not affect salinity preferences (to 5 ppt), suggesting efficient osmoregulation in low salinities (Meador and Kelso 1990b). Young-of-the-year of freshwater and coastal marsh largemouth bass preferred 0-ppt salinity over a gradient (0, 3, 6, 9, 12 ppt). Adult marsh largemouth bass had significantly more observations at 3 ppt, and freshwater bass had significantly more observations at 0 ppt, although both selected 3 ppt most often (Meador and Kelso 1989). Relative to freshwater populations, coastal marsh largemouth bass can reduce osmoregulatory stress at 8 ppt salinity by conserving adenosine triphosphate (ATP), reducing active ion transport, and tolerating elevated plasma ion levels (Meador and Kelso 1990b). Young-of-the-year coastal marsh largemouth bass appear even better able to maintain osmoregulatory function than adults up to 12-ppt salinity, but mortality is severe with 48-hour exposures to 16 ppt (Susanto and Peterson 1996). Exposure to 12-ppt salinity in laboratory trials caused adults from coastal marsh and freshwater populations to cease feeding and die within 7 days (Meador and Kelso 1990b). Coastal marsh largemouth bass also exhibit small size and reduced length at age, but maintain excellent condition (relative weight) year round, indicating that they are not stressed physicochemically by marsh environments (Meador and Kelso 1990a). Marsh-dwelling largemouth bass also exhibit a decided growth response to increasing salinities. In Louisiana coastal populations, growth in length is reduced at 0-ppt salinity and increased at 8 ppt relative to freshwater largemouth bass (Meador and Kelso 1990a). In Mobile Bay, Alabama, first-year growth of largemouth bass along a freshwater to mesohaline gradient of sites was higher in individuals within or adjacent to brackish waters (Peer *et al.* 2006). A short, rotund body is characteristic of coastal largemouth bass (Hallerman *et al.* 1986; Meador and Kelso 1990a), reflecting a redistribution of somatic growth relative to freshwater populations. The body form may be related to being shifted from a position as a cruising top predator in freshwaters to a secondary predator restricted to highly structured edges to avoid larger predators in these piscivore-rich habitats (Meador and Kelso 1990a). Osmoregulatory adaptations, differential growth responses, and body form suggest genetic differences between coastal and freshwater largemouth bass, but no profound biochemical genetic differences emerged in populations examined thus far (Hallerman *et al.* 1986). Oligohaline marsh populations in Mobile Bay possess higher genetic heterozygosities relative to upstream freshwater populations (Hallerman *et al.* 1986), possibly reflecting adaptation to a more dynamic physicochemical environment (Peterson and Meador 1994; Peer *et al.* 2006).

The largemouth bass is tolerant of low DO levels, avoiding only extreme hypoxia and its associated physiological costs. In natural settings, individuals apparently move to streams or other oxygenated refugia to avoid winter-associated low oxygen levels in northern lakes and bogs, reinvading these habitats when DO levels increase in summer (Tonn and Magnuson 1982; Rahel 1984). Likewise, the species appears to avoid hypoxic conditions in densely vegetated southern reservoirs and wetlands during summer temperature extremes (Rutherford *et al.* 2001; Killgore and Hoover 2001). Hypoxia tolerance in the species is size mediated such that small individuals can use more hypoxic waters than large individuals (Moss and Scott 1961; Cech *et al.* 1979; Burleson *et al.* 2001). This is a potentially important factor for young largemouth bass forced by competition or predation to occupy marginal habitats (Burleson *et al.* 2001). Nevertheless, largemouth bass across a range of sizes (23–3000 g at 24°C) avoid extreme hypoxic conditions, seeking water with >27% air saturation (ca. >2.4 mg/l DO) (Burleson *et al.* 2001) but show little or no avoidance to DO concentrations as low as 3.0 mg/l (19–20°C) (Whitmore *et al.* 1960). In laboratory trials largemouth bass show relatively low average critical DO levels (24-hr survival or cessation of ventilation) of 0.70 to 1.2 mg/l (Moss and Scott 1961; Smale and Rabeni 1995a). Embryos develop and hatch at DO levels as low as 1.0, 1.1, and 1.3 mg/l at 15, 20, 25°C but concentrations below 2.0, 2.1, and 2.8 at these respective temperatures significantly lowered survival; most mortality occurred during hatching when oxygen demand is presumably higher (Dudley and Eipper 1975). At 20 and 23°C, DO concentrations as low as 35% saturation are adequate for larvae, but growth is reduced at ≤70% saturation, and at ≤50% saturation hatching of eggs is premature and first feeding delayed (Carlson and Siefert 1974). Hypoxic conditions impose other physiological costs and constraints on largemouth bass. Diurnal low oxygen levels (2.5 to 4.1 mg/l at about 20°C), simulating early morning reductions in DO concentration, produce measurable, stress-related changes in serum proteins, reduce food consumption, cause digestive interference, and increase ventilation rates in largemouth bass (Bouck and Ball 1965). Hypoxic conditions (<5 mg/l at 26°C) reduce growth rate and food consumption of small largemouth bass (62–85 mm TL), but food conversion efficiencies are not affected except at extremely low DO concentrations (≪4 mg/l; Stewart *et al.* 1967). Swimming ability of small largemouth bass decreases with decreasing temperature under hypoxic conditions (Katz *et al.* 1959; Dahlberg *et al.* 1968). For example, juveniles (93–100 TL) were able to swim against a current of 3.8 cm/s for 1 day at DO levels of 2.05 mg/l at 25°C, but were unable to swim against the same current at 2.8 mg/l at 20°C or at 5 mg/l at 17°C. Maximum sustained swimming speed of juveniles was reduced at oxygen concentrations <5 to 6 mg/l (at 25°C) (Dahlberg *et al.* 1968). Intraspecific differences in tolerances of geographically disparate populations of largemouth bass to low DO are notable. For example, largemouth bass from Wisconsin showed lower hypoxia tolerance than largemouth bass from Missouri streams (critical levels of 1.01 versus 0.70 mg/l DO, respectively) (Smale and Rabeni 1995a). In another example, swimming performance and routine oxygen consumption differed between largemouth bass stocks from Illinois and Wisconsin in trials at different temperatures. Notably, hybrid individuals between the stocks showed reduced performance relative to locally adapted stocks, particularly at higher temperatures. In essence, the hybrid stocks displayed performance impairment rather than hybrid vigor, which emphasizes the importance of adaptation to local environmental conditions in largemouth bass (Cooke *et al.* 2001a; Cooke and Philipp 2005, 2006).

Adult largemouth bass are generally more tolerant of lowered pH than egg, larval, and juvenile stages. For example, adults nested and spawned each year as pH in an experimental lake was decreased gradually from 6.1 to 4.7 over several years (Little Rock Lake, WI), but the percentage of nests producing swim-up fry declined significantly with decreasing pH. At pH 5.1, percentage of nests producing swim-up fry fell below that observed in the reference basin and overwinter survival decreased, and no swim-up fry were observed at pH 4.7, a lower limit consistent with laboratory and additional *in situ* tests (Eaton *et al.* 1992; Brezonik *et al.* 1993). In a related laboratory study, juvenile largemouth bass (6.7 g) osmoregulated and survived up to 30 days at pH ≥4.5 but lost osmoregulatory control at pH 4.0 and died within a few days (McCormick *et al.* 1989). Young-of-the-year (2.5–4.5 g) were subjected (at 3.8°C with a simulated spring increase to 18°C) to a graded series of pH (4.5–8.0), two Ca concentrations (1.5 and 13.4 mg/l), and two monomeric Al concentrations (6 and 30 μg/l) for 113 days (McCormick and Jensen 1992; Leino and McCormick 1993). Survival probabilities were most affected at low Ca and high Al levels and were correlated with decreased osmoregulatory function and gill damage. For example, fish at pH 5.0 and high Al levels had a 56% chance of survival to day 84 compared to a 99% chance for fish at the same pH with no Al. Laboratory analyses of behavioral repertoires of young-of-the-year largemouth bass acclimated to decreasing pH suggest that values <6.1 may increase energy demands. At low pH extremes, feeding and swimming activity of young-of-the-year is reduced (Orsatti and Colgan 1987), ultimately increasing risk of starvation.

Food: The largemouth bass is an opportunistic top carnivore, exploiting prey from the bottom to the surface. Adults feed primarily on fishes (e.g., clupeids, yellow perch, *Lepomis* spp., silversides, minnows, topminnows, darters); crayfish and grass shrimp (if available); and large aquatic insects (e.g., odonate and mayfly larvae), including winged adults (Applegate *et al.* 1967; Olmsted 1974; Carlander 1977; Hubert 1977; Cochran and Adelman 1982; Huskey and Turingan 2001; Pope *et al.* 2001; Sammons and Maceina 2006). In their first summer of life, largemouth bass young-of-the-year shift from an initial diet of microcrustaceans to begin exploiting a variety of aquatic insect larvae, especially diptera larvae and pupae and some fish at about 30 to 70 mm TL. Between about 30 and 100 mm TL, individuals begin a usually rapid transition to a diet predominated by small fishes and if available, amphipods, crayfish, or grass shrimp (Keast 1965; Applegate *et al.* 1967; Miller and Kramer 1971; Timmons *et al.* 1980; Keast 1985b,c; Keast and Eadie 1985; Matthews *et al.* 1992; Olson *et al.* 1995; Olson 1996; Miranda and Pugh 1997; Huskey and Turingan 2001; Pelham *et al.* 2001). In fast-growing individuals or cohorts spawned early, the shift to piscivory occurs in the first summer of life, but if food availability or prey size is limiting the shift can be delayed (Kramer and Smith 1960a; Timmons *et al.* 1980; Miller and Storck 1984; Keast and Eadie 1985; Phillipps *et al.* 1995; Olson 1996; Ludsin and DeVries 1997). For example, in a densely vegetated southern reservoir, most juvenile largemouth bass delayed the shift to piscivory until 140 mm TL, relative to ≥60 mm TL after vegetation removal, a delay presumably associated with limited availability of fish prey in the dense vegetation (Bettoli *et al.* 1992). Similarly, late-hatched individuals may not find enough fish prey of suitable size and exploit insect or even zooplankton prey for much of the first year of life (e.g., Phillips *et al.* 1995). Regardless of age, the largemouth bass is adept at exploiting available food resources, feeding almost solely on invertebrates if fish are unavailable or opportunistically preying on vertebrates of terrestrial origin to augment the diet (i.e. salamanders, frogs, snakes, shrews, voles, mice, and birds; Clady 1974; Carlander 1977; Cochran and Adelman 1982; Becker 1983; Hodgson *et al.* 1997; Schindler *et al.* 1997; Ernst and Ernst 2003). In some populations, terrestrial vertebrates contribute substantially to the diet (Clady 1974; Hodgson *et al.* 1997). If large size differences exist among young, or alternate fish prey are unavailable, cannibalism also can contribute a major portion of the juvenile or adult diet, most often involving consumption of young-of-the-year or age-1 bass (e.g., Kramer and Smith 1962; Applegate *et al.* 1967; Clady 1974; Timmons *et al.* 1980; Cochran and Adelman 1982; Hodgson and Kitchell 1987; Olson *et al.* 1995; Hodgson *et al.* 1997; Schindler *et al.* 1997; Post *et al.* 1998; Pothoven *et al.* 1999; Pine *et al.* 2000).

Activity and feeding patterns of largemouth bass are characterized by peaks at or just before dawn, midday, and dusk (Olmsted 1974; Reynolds and Casterlin 1976b; Demers *et al.* 1996). Young-of-the-year, still under the protection of guardian males, and recently dispersed young forage continuously throughout the day, resting at night in cover in shallow water (Elliott 1976; Helfman 1981). Intermediate-size largemouth bass (ca. 6–20 cm) often forage during the day in groups (up to 50) and simultaneously attack schools of prey fishes (Helfman 1981; Becker 1983; Sowa and Rabeni 1995). In adults, feeding tends to show crepuscular peaks, but nocturnal activity, movement, and presumably foraging can be high and extend well after dusk into the early morning hours, especially at high summer water temperatures (>27°C) (Olmsted 1974; Warden and Lorio 1975; Helfman 1981; Demers *et al.* 1996). Although feeding and movement decline as water temperature decreases, largemouth bass actively feed and can grow during the winter at temperatures ≥6°C (Bennett and Gibbons 1972; Olmsted 1974; Warden and Lorio 1975; Hubert 1977; Etnier and Starnes 1993; Garvey *et al.* 1998; Fullerton *et al.* 2000).

The behavior, functional morphology, bioenergetics, and other aspects of the trophic biology and ecology of the largemouth bass are among the most extensively documented of any North American freshwater fish. Aspects of learning and foraging adaptability; prey detection; chemical alarm cues; and predator effects are introduced here. The interested reader is encouraged to consult papers cited in this account on these and other feeding-related topics, including for example, Lewis *et al.* 1961, 1974; Laurence 1969, 1972; Beamish 1972; Niimi 1972a,b; Niimi and Beamish 1974; Heidinger and Crawford 1977; Rice *et al.* 1983; Brown and Colgan 1984; Rice and Cochran 1984; Webb 1986; Hoyle and Keast 1987, 1988; Wahl and Stein 1989; Hambright 1991; Hambright *et al.* 1991; Hodgson *et al.* 1991; Trebitz 1991; Wainwright and Lauder 1992; He *et al.* 1994; Richard and Wainwright 1995; Wainwright and Richard 1995; Wainwright and Shaw 1999; Zweifel *et al.* 1999; Essington *et al.* 2000; and Garvey and Marschall 2003.

Largemouth bass quickly learn to locate, capture, and handle novel prey items, even when shifted from simple to structurally complex habitats. The species can switch among modes of ram strike feeding for water column prey (Norton and Brainerd 1993), suction feeding for benthic prey in crevices, and biting for exposed benthic prey (Nyberg 1971; Winemiller and Taylor 1987). In experimental settings, largemouth bass shifted from a cruising–searching–foraging strategy to an ambush strategy for fish prey as vegetation density was increased (Savino and Stein 1989a,b). Young largemouth bass, often forced into structurally complex habitats to avoid predation, rapidly learned to change foraging tactics in experimental settings. When switched from intermediate to highly structured habitats, the young bass initially used tactics from the previous habitat in the new habitat to capture damselfly nymphs, but individuals modified search and prey selection strategies in a few days to increase capture efficiency in the most structurally complex habitat (Anderson 1984). Learning also plays a role in foraging success of postlarval largemouth bass. Hatchlings raised on natural food (live zooplankton) for 9 weeks were significantly more efficient predators when exposed to live fish than were fry raised on artificial diets. Apparently the fry fed natural foods learned critical aspects of a behavioral repertoire necessary to efficiently capture live fishes. Even so, with exposures to natural diets the artificial diet group improved prey capture efficiency with experience (Colgan *et al.* 1986). In natural settings, the survival to age-1 of stocked pellet-fed largemouth bass is lower than that of individuals fed minnows before stocking (Heidinger and Brooks 2002), providing indirect support for the laboratory findings.

The largemouth bass is a highly vigilant, visual predator but responses to prey or potential predators vary with size, type, and movement of the visual target, light intensity, and water clarity. In choice experiments between close and distant stationary prey, largemouth bass (290 mm TL) chose the closer of two prey of equal size, suggesting that they can judge distances and the absolute size of their prey (or potential predator) (Howick and O'Brien 1983). Largemouth bass also can visually assess the differential risk posed by different aerial predators. Cardiac responses of largemouth bass exposed to a blue heron, a predator with size-restricted predation ability on bass, were greater in smaller more vulnerable largemouth bass than in less vulnerable larger largemouth bass. Bass response to an osprey predator with ability to consume larger fish than a blue heron was also size mediated, but the responses were more extreme than in the heron exposures, and individuals of all sizes required more time for recovery (Cooke *et al*. 2003b). Largemouth bass can see effectively even at relatively low light levels. As light level decreases, adults (290 mm TL) show no obvious decline in reactive distance (>120 cm) to motionless bluegill (60 mm TL) prey until light is <5 lux (Howick and O'Brien 1983); then reactive distances decrease steeply to about 33 cm at 0.195 lux. At low light intensity, differences in reactive distances to prey from 30 to 90 mm TL are minimal. Reactive distances increase when largemouth bass are exposed to moving versus stationary prey of similar size. For example, reactive distances of individual bass of 280 to 300 mm TL to crayfish (at 200 lux) increases linearly with crayfish size (17–29 cm carapace length) but reactive distances to moving crayfish is nearly double that of stationary crayfish (Crowl 1989). As prey size increases to about 65 mm TL, reactive distances to moving and stationary prey types converge (Howick and O'Brien 1983). As turbidity increases reactive distance to crayfish prey (17–29 cm carapace length, at 200 lux) decreases from >150 cm at 3 JTU to about 30 cm at 17 JTU; at the higher turbidity, crayfish size or movement does not increase reactive distances. In turbid water, largemouth bass attacked rectangular stones used to assess prey recognition, a behavior never observed under clear water conditions (Crowl 1989). In another water clarity experiment, largemouth bass (83–130 mm FL) showed a trend of decreased capture rates of fathead minnows as turbidities increased from 1 to 70 NTU (at 430 to 538 lux), the trend driven primarily by a decrease in vulnerability of the smallest size class of prey (26–30 mm FL). Even so, only the most extreme turbidity tested showed a significant reduction in minnow capture rates (Reid *et al*. 1999).

Experimental studies indicate that largemouth bass are not totally dependent on vision for feeding but can integrate nonvisual senses with vision to capture and assess palatability of prey. The pharyngeal teeth of largemouth bass are in close association with numerous taste buds, and this association is linked closely with whether a potential food item is ultimately rejected or swallowed (Linser *et al*. 1998). At light intensities ranging from full moonlight (0.003 lux) to low-intensity daylight (312 lux), adult largemouth bass located and ate 95 to 100% of offered live fish prey in 15-minute trials in large tanks. Foraging success declined to 62% and was highly variable under starlight (0.00026 lux) and further declined to 0% in total darkness (0 lux), but when the total darkness trial was extended to 1 hour, capture success increased to 2.5%. From these results, the threshold for visual feeding by largemouth bass (light intensity at 50% prey capture success) is estimated at 0.00016 lux (McMahon and Holanov 1995), much less than that implied by reactive distance studies (e.g., 1.49 lux, Howick and O'Brien 1983), and suggests that nonvisual senses, such as the lateral line, play a role in prey detection and capture. In an experiment testing the role of the lateral line in feeding, largemouth bass were subjected to a visual stimulus (food) and a lateral line stimulus (water jet) directed at various regions of the head. The water jet, with or without the visual stimulus, always elicited an orientation movement and bite toward the stimulus. In individuals with the lateral line pharmacologically ablated, there was no response to the water jet. The orientation and bite were interpreted as unconditioned responses to lateral line stimulation by the water jet with potential importance to prey location (Janssen and Corcoran 1993). In another feeding experiment, largemouth bass were lateral line ablated, bilaterally blinded, or both, and the distances of first orientation to live fish prey and strike measured. Relative to controls, the lateral line–ablated individuals showed decreased distance of first orientation and strike (i.e. both positions closer to prey). Blinded individuals showed even further decreases in first orientation and strike positions. Strike success (prey capture) decreased along a gradient from 79% in controls, 70% in lateral line–ablated individuals, 59% in blinded individuals, and near 0% in blinded, lateral line–ablated individuals. Without input from the lateral line the threshold at which the bass responds to prey apparently is raised (distance to orientation and strike positions reduced), and the lateral line alone provides sufficient information at the closest ranges to successfully capture prey (New and Kang 2000; New 2002).

Largemouth bass respond to chemical alarm cues, which are released from damaged individuals of heterospecifics (e.g., cyprinids). Juvenile bass undergo an ontogenetic shift in response to heterospecific chemical cues, which coincides with shifts in diet and habitat use. Antipredator responses are supplanted by foraging responses at the time juvenile fish switch from invertivory to piscivory and are large enough to avoid predation from large piscivores. In laboratory and field trials, invertivorous young-of-the-year largemouth bass exhibited significant antipredator responses (e.g., freezing, dropping to substrate) to chemical alarm cues of finescale dace and green sunfish, but larger piscivorous individuals exhibited foraging responses to the same cues. In field trials, small largemouth bass (30–60 mm SL) actively avoided areas injected with dace extract, but slightly larger individuals (61–81 mm SL) were attracted to these areas (Brown *et al*. 2001, 2002).

Even though largemouth bass are highly adaptable foragers, the degree of structural complexity of the habitat affects their foraging success. In a variety of experiments, very dense aquatic vegetation (e.g., >270 stems/m^2) decreases feeding success of largemouth bass (e.g., increased search times, reduced attack rate), but foraging success in intermediate densities is comparable to success rates in low-density or open-water habitats (Savino and Stein 1982, 1989a,b; Anderson 1984; Schramm and Zale 1985; Gotceitas and Colgan 1987, 1989; Hayse and Wissing 1996; Valley and Bremigan 2002). Aspects of growth form, architecture, and spatial heterogeneity of vegetation (or other cover) also affect foraging success of the species (Dibble and Harrel 1997; Valley and Bremigan 2002). Juvenile and adult bass showed dramatic shifts in use of macroinvertebrates and fishes in enclosures of Eurasian milfoil compared to pondweed, the shifts being attributed to differences in the fine architecture of the plant growth forms (Dibble and Harrel 1997). Likewise, attack and consumption rates of largemouth bass on bluegill prey were decreased in monoculture aquatic macrophyte beds forming surface canopies relative to diverse beds with growth dispersed throughout the water column (Valley and Bremigan 2002). In field settings, changes in prey vulnerabilities and prey assemblages with sudden shifts in density and composition of aquatic plant communities can lead to large changes in the diet and in the most densely vegetated habitats can even reduce growth (e.g., delay shift to piscivory) and condition in largemouth bass populations (Wiley *et al.* 1984; Bettoli *et al.* 1991, 1992; Dibble *et al.* 1996; Wrenn *et al.* 1996; Miranda and Pugh 1997; Pothoven *et al.* 1999; Unmuth *et al.* 1999; Brown and Maceina 2002; Sammons and Maceina 2006).

The largemouth bass is considered a keystone species in many streams and lakes because of their profound effects as predators on prey habitat use, community structure, and trophic-level biomasses (e.g., Carpenter *et al.* 1987; Harvey 1991a; Mittelbach *et al.* 1995; Power *et al.* 1996; Schindler *et al.* 1997; Jackson 2002; Miranda and Dibble 2002). The striking patterns of complementary distribution of adult largemouth bass and small-bodied fishes and their interaction as predator and prey formed the foundation for much of our understanding of the importance of biotic interactions in structuring fish assemblages in streams and lakes (e.g., Werner 1977; Werner *et al.* 1977, 1983; Power and Matthews 1983; Mittelbach 1983, 1984a, 1986; Power *et al.* 1985; Werner and Hall 1988; Mittelbach *et al.* 1995). The direct and indirect effects of largemouth bass on aquatic communities have been demonstrated in laboratory experiments, in artificial streams, and in manipulations and empirical studies in streams and lakes.

Largemouth bass elicit strong predator avoidance behaviors from many fishes and other aquatic organisms, behaviors that can produce indirect effects on other components of the community. Laboratory and field studies, most often involving *Lepomis*, document dramatic changes in foraging behavior and habitat use of prey fishes faced with predation risk from largemouth bass (e.g., Savino and Stein 1982, 1989a,b; Morgan and Colgan 1987; Morgan 1988; DeVries 1990; Gotceitas 1990b; Gotceitas and Colgan 1990; Harvey 1991a; Matthews *et al.* 1994; Hayse and Wissing 1996). The foraging strategy of prey fish in the presence of bass may shift from an optimal foraging pattern to one minimizing the ratio of mortality rate to foraging rate (e.g., form more compact shoals, increased time in cover or shallow water, increased swimming rate, decreased foraging rate). Experiments in artificial streams using two grazers, a minnow (*Campostoma anomalum*), and a crayfish (*Orconectes virilis*), with and without largemouth bass, exemplify the potential direct and indirect effects of the species. In the presence of largemouth bass, the minnows formed tighter schools, used shallower habitats, and avoided grazing in pools with bass. Crayfish reduced risk from bass predation by foraging at night, hiding in burrows in the daytime, or avoiding pools used most by the bass (Gelwick 2000); similar reductions in activity and habitat use is documented in other studies of crayfish response to largemouth bass (Hill and Lodge 1994; Garvey *et al.* 1994). Algal growth in the experimental stream was also greater in treatments with largemouth bass and grazers than with grazers alone, suggesting that the bass indirectly affected algal productivity by reducing activity levels and locations of grazers (Gelwick 2000) and supporting results in mesocosm experiments on macrophyte–crayfish–bass interactions (Hill and Lodge 1995).

Empirical and manipulative studies in natural stream settings closely parallel laboratory and artificial stream findings of the effects of largemouth bass on stream communities. In stream pools, the distribution of adult largemouth bass is correlated negatively with many small-bodied stream fishes, providing indirect evidence of a bass effect on potential prey species (Power and Matthews 1983; Power *et al.* 1985; Harvey *et al.* 1988; Matthews *et al.* 1994). When adult largemouth bass were added to or removed from stream pools, prey fishes responded with changes in abundance and habitat use, but the response was size mediated. With addition of bass to pools, juvenile *Lepomis* (16–80 mm TL) rapidly moved to shallow water, but larger *Lepomis* did not appreciably alter their depth distributions. Within a stream pool, the abundance of small stream fishes (16–80 mm TL) decreased with increased bass abundance, and abundance of large fish (>80 mm TL) increased with increased bass abundance. Small fishes remaining in bass-containing pools occupied shallow pool margins, but those in pools without bass used the entire pool. Larval minnows and larval *Lepomis* were only found in pools that contained, or had contained, largemouth bass. Experimental manipulation of bass and *Lepomis* larvae in stream pools indicated that bass presence enhanced short-term survival of the larvae, likely an indirect effect of the shift in small fishes that prey on the larvae (Harvey 1991a). A particularly strong seasonal interaction can occur between largemouth bass, an algae-grazing minnow (*Campostoma anomalum*), and attached algae in stream pools. Large schools of *Campostoma* grazing in stream pools can dramatically reduce algal biomass and composition on stream substrates (Power and Matthews 1983; Matthews *et al.* 1987; Power *et al.* 1988) and influence the life histories of other invertebrates as well (Vaughn *et al.* 1993). In a small prairie-margin stream in Oklahoma, largemouth bass (>70 mm SL) and *Campostoma* showed complementary distributions among stream pools with differential crops of periphyton during summer low flow (Power and Matthews 1983; Power *et al.* 1985). Pools with bass had lush standing crops of epiphyton covering rocky substrates, but in the *Campostoma* pools, epiphyton was confined to pool margins, and most rocky substrates were bare. Experimental addition of bass to pools caused *Campostoma* to immediately emigrate from the pool or move to shallow water margins of the pool. Those that did remain in bass pools spent significantly less time in feeding and more time in cover than they did before bass were added. After bass addition, the standing crop of algae in pools increased significantly within 10 to 13 days (Power *et al.* 1985).

The pattern of abundance of adult largemouth bass and small fishes in streams is congruent with that observed in lake communities. Several studies demonstrate the shift of juvenile bluegill to vegetated or shallow littoral zones as a refuge from predation by *Micropterus* (e.g., Savino and Stein 1982, 1989a,b; DeVries 1990; Gotceitas 1990b; Gotceitas and Colgan 1990) and others demonstrate the indirect effects of largemouth bass on the zooplankton prey of bluegills or other *Lepomis* (e.g., Hambright *et al.* 1986; Werner and Hall 1988; Turner and Mittelhach 1990; Hambright 1994). For example, in pond experiments using largemouth bass and small bluegills, the bass induced a habitat shift in small bluegill, resulting in size distributions skewed toward larger bluegill, a direct predation effect of bass. In turn, the shift to larger bluegill produced pronounced differences in zooplankton abundance and size structure (e.g., three cladocerans and the phantom midge became more abundant in the bass treatment), an indirect effect of bass on the aquatic community (Turner and Mittelbach 1990).

A long-term lake study in which largemouth bass were eliminated by a natural event (1978) and then reintroduced (1986) is further illustration of their role as keystone species in some lakes (Mittelbach *et al.* 1995; see also Carpenter *et al.* 1987; Hall and Ehlinger 1989; Drenner *et al.* 2002). Elimination of bass was followed by a dramatic increase in planktivorous fish (e.g., golden shiner, 400,000/lake), the disappearance of large zooplankton, and the appearance of many small-bodied cladocerans, states which were maintained throughout the period of absence of the bass. On reintroduction of largemouth bass, the lake steadily returned to its previous state. Planktivore numbers decreased by two orders of magnitude (golden shiners being practically eliminated), large-bodied zooplankton reappeared and dominated the zooplankton, and the suite of small-bodied cladocerans disappeared. Total zooplankton biomass increased 10-fold and water clarity increased significantly.

Reproduction: Maturity is usually reached by age 2+ to 4+ at minimum sizes of about 250 to 300 mm TL but can occur at age 1+ in fast-growing populations or be delayed until age 5+ in cool north temperate waters (Bryant and Houser 1971; Webb and Reeves 1975; Carlander 1977; Becker 1983). Spawning activity can begin in early spring at a water temperature as low as 12°C, but most individuals initiate spawning after the water temperature reaches and exceeds 15°C. The spawning season extends over 2 to 10 weeks, peaks between water temperatures of 15 and 21°C, and winds down as waters warm to and consistently exceed 24°C. Spawning occurs from mid-May to mid-June or even early July at north temperate latitudes and shifts to earlier dates at progressively lower latitudes (e.g., mid-March to May or early June in Mississippi and Alabama) (Kramer and Smith 1960a; Allan and Romero 1975; Becker 1983; Miller and Storck 1984; Isely *et al.* 1987; Goodgame and Miranda 1993; Annett *et al.* 1996; Post *et al.* 1998; Sammons *et al.* 1999; Greene and Maceina 2000; Cooke *et al.* 2006). Large adult male and female largemouth bass spawn before smaller adults. The earlier hatched young of large bass often gain and maintain a distinct size advantage over the later hatched young of smaller bass, a size advantage that may increase probability of survival to age 1+ (Miller and Storck 1984; Miranda and Muncy 1987; Goodgame and Miranda 1993; Phillips *et al.* 1995; Ludsin and DeVries 1997; Sammons *et al.* 1999; Pine *et al.* 2000). Males use caudal sweeping to excavate circular, depressional nests (0.6–1.0 m diameter) 1 to 2 days before spawning (Kramer and Smith 1962; Cooke *et al.* 2001b). Males can successfully sweep out nests over a variety of substrates (e.g., silt to boulders, stump tops, logs, clay slabs), but coarse gravel and sand and the roots and stems of aquatic vegetation are substrates most often used (Reighard 1906; Miller and Kramer 1971; Allan and Romero 1975; Annett *et al.*

1996; Hunt *et al*. 2002). Most males select nest sites near simple cover (e.g., horizontal log, tree trunk) where they suffer less nest intrusion by brood predators and expend less effort in aggressive actions than males selecting sites near complex cover (e.g., brush piles, patches of aquatic macrophytes) (Annett *et al*. 1996; Hunt *et al*. 2002). Although a few nests have been reported from >6 m depth, most nests are placed in water <4 m deep with average or median depths ranging from 0.40 to 2.1 m (Kramer and Smith 1962; Miller and Kramer 1971; Allan and Romero 1975; Heidinger 1975; Vogele and Rainwater 1975; Hunt *et al*. 2002). Largemouth bass males are solitary nesters. Average internest spacing ranged from 6.2 to 9.4 m in an Arkansas reservoir or about 15 nests/100 m transect (Hunt and Annett 2002), but other studies reported much lower densities of <1 to 3.0 nests/100 m of shoreline (Vogele and Rainwater 1975). Courting males may leave the nest for extended periods and approach a nearby female, using gentle nudges to her opercular area to direct her toward the nest (Cooke *et al*. 2001b). Males may also seem to lose buoyancy, float upward, and turn on their side to flash their lighter ventral side toward nearby females, which also appears to attract the female to the nest (Allan and Romero 1975). While courting the female or guarding embryos or fry in the nest, parental males engage in a number of vigilant and aggressive behaviors (e.g., hovering, pivoting, nest circling, opercle flaring, chasing, biting, parallel swims) (Allan and Romero 1975; Hunt 1995). Once the female is led to the nest, the male uses nips and nudges near her vent and opercle to encourage egg deposition (Cooke *et al*. 2001b). The pair ultimately assumes the head-to-head, broadside orientation of most centrarchids for spawning (Reighard 1906; Allan and Romero 1975). Spawning activity can be intense, involving up to 123 shudders per hour, and a complete spawning sequence with a single female including pauses between spawning bouts can last for over 3.5 hours (Cooke *et al*. 2001b). After the female departs the nest, the male immediately begins vigilance behaviors (e.g., pivoting) and gentle fanning of the eggs. Although males may occasionally mate with more than one female (Reighard 1906), most mating is monogamous. In a North Carolina population subjected to genetic parentage analysis, eggs in 23 of 26 nests were exclusively or almost exclusively composed of full-sib progeny, the products of one male and one female; the other three nests were indicative of serial monogamy (one male with two or three females; DeWoody *et al*. 2000b). In tagged individuals in experimental ponds, six of seven male largemouth bass spawned with one female and only one male spawned with two females (Cooke *et al*. 2001b). Ovaries begin development for the next spawning season in the fall and continue developing over winter (Olmsted 1974; Brown and Murphy 2004, Florida bass × largemouth bass hybrids). Mature ovarian eggs are 0.75 to 1.56 mm diameter, and the yellow to orange, fertilized, water-hardened eggs average 1.60 to 2.09 mm diameter, increasing in diameter with female size (Kelley 1962; Meyer 1970; Merriner 1971a; Cooke *et al*. 2006). Fecundity increases with female size, and ovaries apparently contain one distinct mode of mature ova, suggesting that females release a single batch of eggs (Kelley 1962; Olmsted 1974). The relationship between potential batch fecundity (Y) and total length (X) is described by the power function, $Y = 0.00003X^{3.4067}$ ($n = 36$, $R^2 = 0.70$, data from Kelley 1962 and Olmsted 1974). At 388 mm TL, a female can potentially produce 19,792 mature eggs in a single batch (range: 4550 eggs at 252 mm TL to 54,732 eggs at 523 TL). The adhesive, fertilized eggs hatch in about 3 to 4 days at 18 to 21°C (Kramer and Smith 1960a; Laurence 1969; Allan and Romero 1975). Newly hatched larvae are 3.6 to 4.1 mm TL (Cooke *et al*. 2006) and at 19°C average 6.2 mm TL (range, 5.9–6.3 mm TL) at the swim-up stage 6.75 days after hatching (Kramer and Smith 1960a; Meyer 1970; Goodgame and Miranda 1993). Male largemouth bass invest 20 to 39 days in parental care from spawning to fry dispersal (Kramer and Smith 1962; Cooke *et al*. 2006). Male defensive behaviors and hence activity and energy expenditures increase through the embryo to swim-up stages (Hunt 1995; Cooke *et al*. 2006). Largemouth bass fry begin leaving the nest about 8 to 11 days after spawning by forming initially tight schools or fry balls that begin to forage away from the nest area. The male bass guards the fry balls by constantly patrolling the areas around the moving fry ball. With growth of the fry, the brood association becomes looser and two or more broods may join, further increasing the peripheral area the male must patrol. The fry remain in swarms until they reach about 28 to 33 mm TL (Kramer and Smith 1962; Allan and Romero 1975; Elliott 1976; Colgan and Brown 1988; Annett *et al*. 1996). Relative to similar-age rock bass fry, largemouth bass fry display reduced predator avoidance responses during their first 3 weeks of free swimming, responses related directly to the extended period of protection provided to the fry by male largemouth bass. About 45 to 50 days after swim-up and after the guarding male parent has left, largemouth bass fry develop agonistic behaviors toward conspecifics, coincidental with the breakup of the large swarms of fry into solitary individuals or pairs (Brown 1984). Juvenile largemouth bass show evidence of natal fidelity. Tagged age-0 largemouth bass in a reservoir remained within a 250-m home range during their first year of life, and 79 to 90% of recaptures were within 58 m of release sites. Of a small number of recaptured yearlings (second summer of life), 56% were still within 58 m of the release site of the previous year (Copeland and Noble 1994; Jackson *et al*. 2002).

Biparental care is documented in a largemouth bass population in a North Carolina stream. Most of 26 nests examined were attended by a female and a guardian male (DeWoody *et al.* 2000b). The attendant female generally faced the nest from 1 to 2 m distance with the attendant male over the nest, but these positions were occasionally reversed. The guardian male showed no aggression toward the female, and the attendant female actively chased away conspecific nest intruders and predators. Nests with attendant females occurred across several stages of brood development, indicating that female nest guarding extended well past spawning and incubation of eggs to the free-swimming fry stage of the brood. A few nests that lacked parental males were guarded solely by females. Biparental care in largemouth bass (or other *Micropterus*) populations is not a general occurrence across populations (Cooke *et al.* 2006), but observation of two individual Florida bass guarding a single nest for 3 days (Carr 1942) and other anecdotal accounts (Miller 1975) suggest that some as yet undocumented degree of biparental care may exist in other populations of largemouth bass or other species of *Micropterus*. The existence of biparental care in the largemouth bass is consistent with several reproductive life history traits (i.e. large body size, large eggs, sexual monomorphism, monogamy, extended parental care; DeWoody *et al.* 2000b).

Nest associates: Golden shiner, *N. crysoleucas* (Kramer and Smith 1960b).

Freshwater mussel host: Confirmed host to *A. ligamentina, A. neislerii, A. plicata, A. suborbiculata, A. ferussacianus, E. complanata, E. fisheriana, L. altilis, L. cardium, L. higginsii, Lampsilis ornata, L. perovalis, L. rafinesqueana, L. siliquoidea, L. subangulata, L. complanata, L. recta, L. subrostrata, M. nervosa, P. grandis, S. undulatus, S. subvexus, V. iris* (reported as *V. nebulosa*), *V. nebulosa*, and *V. vibex* (Lefevre and Curtis 1910, 1912; Young 1911; Howard 1914, 1922; Reuling 1919; Coker *et al.* 1921; Howard and Anson 1922; Arey 1923, 1932; Penn 1939; Neves *et al.* 1985; Waller *et al.* 1985; Waller and Holland-Bartels 1988; Barnhart and Roberts 1997; Haag and Warren 1997; Hove *et al.* 1997; Haag *et al.* 1999; O'Brien and Brim Box 1999; Watters and O'Dee 1999; Khym and Layzer 2000; O'Dee and Watters 2000; O'Brien and Williams 2002; Van Snik Gray *et al.* 2002; Haag and Warren 2003). Putative host to *L. abrupta* (unpublished sources in OSUDM 2006).

Conservation status: Although secure within most of its native range and widely established outside its native range, the largemouth bass is not without major conservation concerns. The genetic integrity of the species in the southern United States is threatened by the widespread and decades-long practice of stocking nonnative Florida bass (or Florida-largemouth hybrids) on top of existing native largemouth bass populations (Philipp *et al.* 2002). Where introduced, Florida bass often rapidly and substantially introgress with native largemouth bass populations, eventually producing hybrid populations with high potential for loss in reproductive fitness and loss in adaptation to local conditions (Philipp *et al.* 1985a, 2002; Fields *et al.* 1987; Cooke *et al.* 2001a; Kassler *et al.* 2002; see account on *Micropterus floridanus*). Even largemouth bass populations in relatively close geographic proximity can differ significantly with respect to growth, survival, reproductive fitness, or physiological responses to the environment, reflecting the adaptation of the stock to the region in which it evolved (Philipp and Claussen 1995; Cooke *et al.* 2001a; Cooke and Philipp 2005, 2006). At least some native populations of largemouth bass in Mexico and perhaps southwest Texas likely represent distinct taxa that could be threatened by further introductions of nonnative largemouth bass or congeners (Edwards 1980; Miller 2005; Lutz-Carillo *et al.* 2006). Two tasks appear primary to the conservation of the genetic integrity of native largemouth bass (Philipp *et al.* 2002): identification of the number and geographic distribution of genetic stocks across the native range of the species and the reconstruction of native stocks now lost or contaminated by past (and present) stocking of nonnative Florida bass, intergrades, or even nonlocal stocks of largemouth bass.

Similar species: All other species of *Micropterus*, except the Florida bass, have more confluent dorsal fins, upper jaws that reach to or barely past the eye, and unbranched pyloric caeca (Page and Burr 1991; see account on Florida bass).

Systematic notes: *Micropterus salmoides* forms a sister pair with *M. floridanus* (Near *et al.* 2004, 2005; see account on *M. floridanus*). At least some native populations of *Micropterus*, currently under the name *M. salmoides*, in the Rio Grande system, appear to represent distinet, but formally unrecognized taxa (Bailey and Hubbs 1949; Edwards 1980; Miller 2005).

Importance to humans: The largemouth bass is the most popular and economically significant freshwater sport fish in North America, perhaps rivaled only by the rainbow trout in its local, regional, and ultimately national economic and social impact. Over its broad native and introduced range in North America, the largemouth bass was the primary impetus over the last 30 years for the founding of hundreds of bass-focused fishing clubs and national angler associations and federations, all of which effectively lobby local, state, and federal agencies and governments and influence fisheries management and conservation (Dean 1996; Shupp 2002; Chen *et al.* 2003; Schramm and Hunt 2007). Broad ecological and habitat tolerances, explosive and aggressive attacks on just about any moving natural or artificial bait, a relatively large size, and excellent table qualities combine as winning characteristics among anglers. Anglers successfully take largemouth bass day or night, across seasons, and in almost every conceivable type of water condition (e.g., Heidinger 1975; Becker 1983; Etnier and Starnes 1993). Largemouth bass anglers range from subsistence fishers in rural areas to a growing cadre of amateur and professional anglers following regional and national largemouth bass tournament trails to compete for hundreds to hundreds of thousands of dollars in cash and prizes (Ross 2001; Shupp 2002; Leonard 2005; Schramm and Hunt 2007). Bass tournaments are often sponsored by large media and corporate interests and broadcast nationally as sporting events. Tournament sponsors manufacture and distribute highly specialized bass fishing equipment (e.g., bass powerboats), bass fishing television shows, "how-to" bass fishing videos, and print media, all of which renders largemouth bass fishing both a spectator and a participatory sport (Ridgway and Philipp 2002). For decades, the largemouth bass in combination with the bluegill has formed the core predator–prey combination used in management of warmwater ponds and small public and private warmwater impoundments (Bennett 1948; Swingle 1949). Historically, the species supported commercial fisheries in the Great Lakes, Ohio, and Illinois (Mills *et al.* 1966; Trautman 1981; Scott and Crossman 1973). For example, before 1900, thousands of barrels of largemouth bass were taken commercially from impoundments in Ohio, and in 1897, an estimated 13,000 pounds of largemouth bass were taken commercially from lakes along the Illinois River.

13.9.8 *Micropterus treculi* (Vaillant and Bocourt)

13.9.8.1 Guadalupe bass

Characteristics: See generic account for general characteristics. Elongate, slightly compressed body depth 0.20 to 0.25 of TL. Mouth large, terminal, lower jaw slightly projecting, upper jaw extends to rear half of eye (in adults). Outline of spinous dorsal fin curved. Juncture of soft and spiny dorsal fins slightly emarginate, broadly connected. Shortest dorsal spine at emargination of fin, 0.5 to 0.6 times length of longest spine. Dorsal soft rays, usually 12, 11 to 13; anal soft rays, usually 10, 9 to 11. Gill rakers, 8. Lateral scales, (55)61 to 69; rows above lateral line (7)8 to 9(10); rows below lateral line, (14)15 to 18(20); cheek scale rows, (10)12 to 14(18); caudal peduncle scale rows, (23)26 to 27(29); pectoral rays, (14)15 to 16. Small scales on interradial membranes at anal and second dorsal fin bases (>60 mm SL). Pyloric caeca, single, usually 10 to 11, (8–13). Tooth patch present on glossohyal (tongue) bone (Hubbs 1927; Hubbs and Bailey 1942; Edwards 1980; Kassler *et al.* 2002).

Size and age: Age 0+ fish average from 82 to 103 mm TL at age 1 (Edwards 1980). Large individuals weigh 500 to 1000 g and attain 250 to 330 mm TL; few live beyond age 3+ (maximum about 400 mm TL, age 6+) (Boyer *et al.* 1977; Edwards 1980; Page and Burr 1991; Koppelman and Garrett 2002). World angling record, 1.67 kg, Texas (IGFA 2006). The oldest individuals in a population are generally females (Edwards 1980).

Coloration: Similar to spotted bass but has 10 to 12 dark vertical blotches along side (diamond shaped posteriorly and darkest in young), usually 16 pectoral rays, and 26 to 27 caudal peduncle scale rows (Edwards 1980; Page and Burr 1991).

Native range: The Guadalupe bass is native to the Edwards Plateau in the Brazos, Colorado, Guadalupe, and San Antonio river drainages, Texas (MacCrimmon and Robbins 1975; Page and Burr 1991; Koppelman and Garrett 2002). Established populations in the Nueces River, Texas, were introduced deliberately in 1973 (Koppelman and Garrett 2002).

Habitat: The Guadalupe bass inhabits gravel riffles, runs, and flowing pools of clear creeks and small to medium rivers (Edwards 1980; Page and Burr 1991). The species is most common in flowing waters of streams (6–22 m wide) in association with large rocks, cypress roots, stumps, or other cover. Individuals overwinter in deep pools with currents, move in spring to shallow, but flowing, backwaters to spawn, and then to deep runs and flowing pools. The species avoids the constant thermal environments of headsprings, extremely silted streams, and the smallest headwater streams. Survival is poor in hypolimnetic-release tailwaters and most reservoirs, except in variable-level reservoirs that provide flowing conditions for at least part of the year (Edwards 1980).

Food: The Guadalupe bass is an opportunistic top carnivore (Edwards 1980). The adult (>90 mm SL) diet is dominated by small fishes, mostly minnows (e.g., *Notropis, Cyprinella, Campostoma*) and other centrarchids, but also includes large numbers of mayfly, dragonfly, dipteran, hemipteran, and megalopteran larvae, a few bees and wasps, and an occasional amphibian. Large adults (>150 mm SL) consume relatively large volumes of crayfish. Fish prey associated with flowing water (e.g., blacktail shiner, darters, channel catfish) are taken most often, an indication of the primary foraging habitat of Guadalupe bass. By volume, the diet of young bass (15–30 mm SL) is dominated by mayfly, odonate, and hemipteran larvae. In bass between 30 and 90 mm SL, increasing volumes of fish are consumed, but invertebrates remain important components of the diet of bass <135 mm SL (Edwards 1980). Dietary comparisons between sympatric populations of Guadalupe bass and largemouth bass indicated decreasing similarity with growth in the numbers and volumes of diet items shared. Where spotted and largemouth basses occurred in sympatry with Guadalupe bass, Guadalupe bass diets were most similar among seasons to those of the spotted bass (Edwards 1980).

Reproduction: Maturity is reached minimally in males at 97 mm TL and age 1+ and in females at 128 mm SL and age 2+ (Hurst *et al.* 1975; Edwards 1980); reported maturation of a female at 70 mm SL (Hurst *et al.* 1975) is perhaps feasible but needs further confirmation (Edwards 1980). With the possible exception of the redeye bass, Guadalupe bass apparently mature at smaller sizes than any other *Micropterus*. Spawning initiation and duration are not well documented, but various observations suggest a mid-March to June spawning period. Male and female gonadosomatic ratios peak in spring, but some individuals taken in summer continue to have elevated ratios. In mid-March, a male was observed guarding a nest and eggs (water temperature 14–17°C), and many large males and females emit freely flowing sex products at that time. Young <30 mm SL are taken from May through August, and recently spent females are observed as late as July (*et al.* Hurst *et al.* 1975; Boyer *et al.* 1977; Edwards 1980). Nesting areas are apart from, but always near, a source of slow to moderately flowing water (i.e. backwaters with water inflow) (Edwards 1980). A single observed depressional nest was oval shaped (41 × 50 cm, 10 cm in depth), placed 1 m from shore on a sloping bank at a water depth of 69 cm and current speed of about 0.3 m/s. The nest was swept into the hard black soil of the creek bank and lined with 5 cm diameter limestone rubble that was covered partially by sticks and leaves. The nest was guarded by a relatively large (280 mm TL) male, and a second individual, suspected to be a female, was also observed near the nest. The nest contained 1406 adhesive eggs, most of which were adhered to the sticks and leaves (Boyer *et al.* 1977). Apparently, nothing else is published on nest building, courtship, spawning, or parental care behaviors. Mature ovarian eggs average from 1.50 to 2.25 mm in diameter, and fertilized water-hardened eggs average 2.1 mm in diameter (Boyer *et al.* 1977; Edwards 1980). Fecundity increases with female size. The relationship between potential batch fecundity (Y) and standard length (X) is described by the linear function, $Y = 29.98X - 3072.20$ (Guadalupe River; $Y = 34.28X - 4144.08$, Llano River; $Y = 57.85X - 5920.62$, LBJ reservoir, equations from Edwards 1980). At 203 mm SL, a female can potentially produce 3013 mature eggs in a single batch (range: 765 eggs at 128 mm SL to 5262 eggs at 278 mm SL, respectively). With growth, young Guadalupe bass occupy increasingly faster and deeper water during their first summer, shifting to deeper-flowing pools to overwinter (Edwards 1980).

Nest associates: None known.

Freshwater mussel host: None known.

Conservation status: The Guadalupe bass is vulnerable throughout its native range (Warren *et al.* 2000; NatureServe 2006). The species has declined dramatically in recent history because of decreased stream flow, reservoir construction, habitat degradation, and extensive, introgressive hybridization with nonnative smallmouth bass (Edwards 1980; Whitmore and Butler 1982; Whitmore 1983; Morizot *et al.* 1991; Koppelman and Garrett 2002). Genetic contamination of the Guadalupe bass from hybridization with nonnative smallmouth bass is pervasive throughout its range, and only five natural populations remain free from introgressive hybridization (Koppelman and Garrett 2002). Genetically uncontaminated Guadalupe bass are being stocked in an attempt to numerically and reproductively overwhelm the hybrid swarms (Koppelman and Garrett 2002).

Similar species: See account on spotted bass and the section on coloration.

Systematic notes: *Micropterus treculi* is a member of a "Gulf of Mexico" clade of *Micropterus,* including all other *Micropterus* except *M. dolomieu* and *M. punctulatus* (Near *et al.* 2003, 2004). Although relationships within the clade are not well resolved, phylogenetic analyses usually recover *M. treculi* as sister to *M. salmoides*+*M. floridanus* (Kassler *et al.* 2002; Near *et al.* 2003, 2004, 2005). On the basis of morphology, taxonomists usually related *M. treculi* to *M. punctulatus* (e.g., Hubbs and Bailey 1942; Huhbs 1954; Ramsey 1975).

Importance to humans: The Guadalupe bass is designated the State Fish of Texas in recognition of the unique character of both the species and its habitat. Although small relative to congeners, the species is the focus of a popular sport fishery on the Edwards Plateau. The species provides good sport using ultralight gear with spinners and other small bass lures that are fished in riffle areas, flowing pools, or deep eddies below riffles (Boyer *et al.* 1977). The fishery provides the angler with an agile fast water fish occurring in attractive, natural stream settings (Koppelman and Garrett 2002).

13.10 *Pomoxis* Rafinesque

The genus *Pomoxis*, consisting of the sister pair *Pomoxis annularis* and *Pomoxis nigromaculatus*, is sister to a clade inclusive of the genera *Archoplites* and *Ambloplites* (Near *et al.* 2004, 2005). The natural range of the genus, collectively called the crappies, encompasses North America east of the Rocky Mountains from southern Canada to the Gulf of Mexico, excluding the Atlantic Slope from southern Virginia northward (Page and Burr 1991). A fossil species, *Pomoxis* †*lanei* Hibbard, is known from Miocene deposits in Kansas and Nebraska with the oldest formations being the Rhino Hill Quarry and is dated at 6.6 mya (million years ago) (Uyeno and Miller 1963; Schultz *et al.* 1982; Cross *et al.* 1986). Another undescribed fossil species presumably representing *Pomoxis* was reported from material collected at the Wakeeney local fauna (Ogallala Formation) in Kansas dating to about 12 mya (Wilson 1968; Tedford *et al.* 1987).

The white crappie and black crappie show wide overlap in distribution across their large ranges and frequently co-occur in the same water body. Nuclear-encoded allozyme data indicate that some sympatric populations of white crappies and black crappies in reservoirs introgress through hybridization, although other sympatric populations do not (Maceina and Greenbaum 1988; Hooe and Buck 1991; Dunham *et al.* 1994; Epifanio and Philipp 1994; Smith *et al.* 1994, 1995; Travnichek *et al.* 1996). Estimates of the degree of hybridization among reservoirs is variable (e.g., none to >40% of individuals,), but second-generation (or higher) hybrids are usually less common than first-generation hybrids and contribute little to recruitment (Smith *et al.* 1994; Dunham *et al.* 1994; Travnichek *et al.* 1996). Within-reservoir differences in species abundances and habitats or among-reservoir differences in physicochemical characteristics are not related in any obvious way to the degree of hybridization. Some speculate that hybridization may be related to contact between the species in artificial environments where habitats or physical conditions limit species recognition or species segregation during spawning, particularly in geographical areas at the historical border of the range of the white crappie (Travnichek *et al.* 1996, 1997; Epifanio *et al.* 1999).

A hallmark of the genus *Pomoxis* is the capacity of both species to maintain high recruitment and rapid growth to harvestable sizes under high mortality or fishery exploitation rates. Sustainable sport fishery exploitation rates of crappies as high as 40 to 60% per year are observed in many impoundments (Colvin 1991; Larson *et al.* 1991), but because of their capability to proliferate, crappies are prone to overpopulation and stunting, especially in small or resource-limited reservoirs (Hooe and Buck 1991; Hooe *et al.* 1994). Crappies were exploited commercially in natural lakes from Florida to Canada well into the twentieth century (e.g., Schoffman 1940, 1960, 1965; Huish 1954; Scott and Crossman 1973; Trautman 1981; Schramm *et al.* 1985). From 1938 to 1955, crappies were liberally harvested in a commercial fishery in Reelfoot Lake, Tennessee, and supported a thriving sport fishery. Soon after cessation of commercial fishing the population was reportedly overrun by smaller crappies (Schoffman 1960, 1965). As recently as 1976 to 1981, the black crappie was commercially fished in Lake Okeechobee, Florida. Commercial fishers and anglers removed about 3.8 million kg of the species (about 833,000 kg/yr; 65% of annual average standing crop) from the lake until the fishery collapsed in 1981 because of highly variable recruitment (Schramm *et al.* 1985; Miller *et al.* 1990).

From a management perspective, and in spite of the ability to proliferate, a perplexing characteristic of the genus is the near unpredictability of survival of fishes beyond their first year of life. Annual recruitment of both crappie species is notoriously erratic, often quasi-cyclical, and highly variable from year to year within a given population. Variability in postspawning larval abundance and subsequent recruitment of both crappie species can often be related to complex interactions among population dynamics and lake conditions or reservoir operations. These often involve combinations of factors such as larval densities, hatch times, harvest rates, water body productivity, prespawning water temperatures, water retention time, water elevation, or dam discharge rates that may predict crappie recruitment in some, but not other waters (e.g., Beam 1983; McDonough and Buchanan 1991; Mitzner 1991; Allen and Miranda 1998, 2001; Maceina and Stimpert 1998; Sammons and Bettoli 1998; Miranda and Allen 2000; Pine and Allen 2001; Sammons *et al.* 2001, 2002; Dubuc and DeVries 2002; Maceina 2003; St. John and Black 2004; Dockendorf and Allen 2005; Bunnell *et al.* 2006).

The black crappie and white crappie support a popular sport fishery and on a kilogram per hectare basis are the most harvested fish in reservoirs of the United States (Miranda 1999). Of all freshwater anglers (exclusive of the Great Lakes) in the United States, an estimated 24% (6.7 million) of anglers spent 21% (95 million days) of fishing days seeking crappies (USFWS 2002). These percentages compare favorably with popularity of sport fisheries for catfish, panfish, and trout. On some southern US reservoirs much if not most (>30%) of the angling effort is directed at crappies (e.g., Larson *et al.* 1991; Reed and Davies 1991; St. John and Black 2004). A growing contingency of crappie anglers are considered "specialists," similar to many black bass anglers, because they fish year round for crappies to the near exclusion of other species. The relatively recent advent of crappie clubs and fishing tournaments, dubbed crappiethons, are further evidence of the continued and growing popularity of sport fishing for these centrarchids (Larson *et al.* 1991; Allen and Miranda 1996).

Generic characteristics: Deep, extremely compressed body, depth about 0.33 to 0.48 of SL. Long to very long predorsal region with sharp dip over eye in dorsal profile. Dorsal fin base equal to or shorter than distance from center of eye to dorsal fin origin. Head small. Eye large, diameter equal to or slightly greater than snout length. No black teardrop; no black spot in soft dorsal fin. Dorsoposterior margin of opercle shallowly emarginate. Preopercle posterior margin serrate. Long dorsal fin, 6 to 8 spines, 13 to 18 rays, 20 to 24 total; and long anal fin, 5 to 8 spines, 14 to 18 rays, 23 to 24 total. Spiny and soft dorsal and anal fins continuous, smoothly rounded, similar in length, and nearly symmetrical. Emarginate to shallowly forked caudal fin. Rounded pectoral fin. Long, slender gill rakers, 25 to 32. Ctenoid scales. Lateral line complete. Lateral line scales, 34 to 50; cheek scale rows, 5 to 6; branchiostegal rays, 7. Teeth on entopterygoid and glossohyal (tongue, two patches) bones (Bailey 1938; Keast 1968a; Trautman 1981; Becker 1983; Smith 1985; Page and Burr 1991; Etnier and Starnes 1993; Mabee 1993; Jenkins and Burkhead 1994; Smith *et al.* 1995).

Similar species: See account on flier.

13.10.1 Pomoxis annularis *Rafinesque*

13.10.1.1 White crappie

Characteristics: See generic account for general characteristics. Deep, extremely compressed body, depth usually 0.33 to 0.48 of SL. Very long predorsal region with sharp dip over eye in dorsal profile. Dorsal fin base shorter than distance from center of eye to dorsal fin origin. Large, supraterminal, oblique mouth, lower jaw projecting, supramaxilla moderate ($\leq$2 times length of maxilla), upper jaw reaching to or slightly beyond middle of eye. Opercular spot black. Long dorsal fin, (4)5 to 6(8) spines, (12)14 to 15(16) rays; and long anal fin, 6 to 7(8) spines, 16 to 19 rays. Pectoral rays, (14)15(16); vertebrae, 30 to 32(14+18) (Bailey 1938; Trautman 1981; Becker 1983; Page and Burr 1991; Etnier and Starnes 1993; Mabee 1993; Jenkins and Burkhead 1994; Smith *et al.* 1995).

Size and age: Typically reach 131 to 173 mm TL at age 1, but first-year growth is highly variable across latitudes and among habitats (range, 58–310 mm TL, Siefert 1969a; Carlander 1977). Large individuals measure 350 to 400 mm TL, weigh 500 to 800 g, and reach age 6+ to 8+ (maximum 530 mm TL, age 9+) (Carlander 1977; Page and Burr 1991; Etnier and Starnes 1993). World angling record, 2.35 kg, Mississippi (IGFA 2006).

Coloration: Gray-green above with silvery blue sides and upper back vaguely barred with about 6 to 10 chainlike double vertical bands (widest at top) as well as dark blotches and green flecks. Chainlike bars and mottling often faint in individuals from turbid water. Whitish to silvery below. Dorsal, anal, and caudal fins with many wavy dark bands and spots. Males become darker during the breeding season (Page and Burr 1991; Etnier and Starnes 1993).

Native range: The white crappie is native to the Great Lakes, Hudson Bay (Red River), and Mississippi River basins from New York and southern Ontario west to Minnesota and South Dakota and south to the Gulf of Mexico and in Gulf drainages from Mobile Bay, Georgia and Alabama, west to the Nueces River, Texas (Page and Burr 1991). The species has been introduced and is established over most of the coterminous United States (Fuller *et al.* 1999).

Habitat: The white crappie inhabits sand- and mud-bottomed pools and backwaters of creeks and small to large rivers, lakes, ponds, and reservoirs (Page and Burr 1991). The greater adaptability of the white crappie to turbid waters than the black crappie is often noted. Higher relative abundance or success in turbid habitats suggests that the white crappie is more adapted to turbid conditions than the black crappie (e.g., Carlander 1977; Trautman 1981; Ellison 1984; Etnier and Starnes 1993; Miranda and Lucas 2004). Even though the difference in turbidity tolerance is frequently noted, both crappie species occur in turbid and clear water habitats, and an obvious mechanism or adaptation explaining the apparent difference in tolerance is lacking (e.g., Barefield and Ziebell 1986). Some indirect evidence (e.g., growth, survival) suggests that white crappies can feed more efficiently in turbid waters than black crappies or that white crappies compete poorly in clear waters with other centrarchids (e.g., Carlander 1977; Ellison 1984; Pope 1996). White crappies move extensively, often show distinct diel activity patterns, and can show persistent occupation of home activity areas in the summer. In rivers in Missouri, tagged individuals covered 34 to 42 km in 21 to 91 days (Funk 1957) and others have noted movements up to 30 km (review in Hansen 1951; Siefert 1969a). Increased movement in spring and early summer is attributed to aggregation in spawning areas and postspawning foraging (Guy *et al.* 1994). Adult white crappies show high levels of nocturnal activity (see section on food), but overall patterns of movement and activity vary seasonally and daily among seasons (e.g., Hansen 1951; Morgan 1954; Greene and Murphy 1974; Markham *et al.* 1991; Guy *et al.* 1994). In an Ohio reservoir, diel movement of large white crappie (271–352 mm TL) in summer rapidly increased at dusk when light intensity was zero, peaked at night (average 47 m/h), and declined at dawn. Movement was low throughout the day (average 17 m/h). During the day, the species was associated with steeply sloped bottoms and the presence of structure (e.g., tree stumps, logs, rocks). Individuals tended to occupy deeper water during the day than at night (e.g., 5.4 vs 4.3 m, respectively), generally staying within 0.5 m of the bottom. Median summer home activity areas were 0.49 to 0.63 ha during the day and 1.25 ha at night (Markham *et al.* 1991). In a shallow, homogeneous glacial lake in South Dakota, movement patterns of large radio-tagged white crappie tracked from April to September were more extensive and less patterned. Over the tracking period, median movement was 73.2 m/h (range: 0–1,523 m/h) and was highest in May (102.1 m/h) and July (82.4 m/h). Diel movement patterns were indistinct or variable, but tended to peak at dawn and dusk. Median home activity area was large relative to the reservoir study (15.8 ha) and varied considerably (range: 0.1–85.0 ha) (Guy *et al.* 1994). The larger home range, relative to the other study, was attributed to greater foraging demands or the lack of cover and bottom structure in the homogeneous habitat of the lake. Cover or structure tends to hold individuals within a limited area for prolonged periods (Markham *et al.* 1991; Guy *et al.* 1994).

Food: The white crappie is primarily a midwater, particulate-feeding zooplanktivore and invertivore that shifts to piscivory at a relatively large size (~ 160 mm TL) compared to other piscivorous centrarchids (O'Brien *et al.* 1984). Numerous, long gill rakers likely play an important functional role in the extended period of zooplanktivory (Wright *et al.* 1983). Food of large individuals (>160 mm TL) consists primarily of small fishes (e.g., clupeids, other white crappies and sunfishes, minnows, silversides), zooplankton, immature aquatic insects (e.g., chironomid larvae and pupae, burrowing mayflies), and amphipods (e.g., Hansen 1951; Morgan 1954; Hoopes 1960; Whiteside 1964; Siefert 1969a; Mathur 1972; Greene and Murphy 1974; Ellison 1984; Muoneke *et al.* 1992). Large white crappies are among the best documented of any centrarchid for their nocturnal feeding and high levels of nocturnal activity (see section on habitat). Large individuals feed at dusk, sporadically throughout the night, and intensively at dawn, feeding very little or not at all during the day (Childers and Shoemaker 1953; Greene and Murphy 1974). In lentic waters, intermediate-size fish (80–150 mm TL) are pelagic zooplanktivores that begin feeding at or near dawn and continue feeding throughout the day (O'Brien *et al.* 1984; Wright and O'Brien 1984). These pelagic-dwelling individuals can make diel vertical migrations to exploit vertically migrating zooplankton and dipteran larvae and pupae and to respond to changing levels of temperature, light, and DO (O'Brien *et al.* 1984). Empirical associations of white crappie abundance and abundance of other fishes in wild populations and mesocosm experiments indicate that 130 to 199 mm TL white crappie are highly effective predators that rapidly find and eat larval fishes (e.g., bluegills, walleye). Predation by white crappies is so effective it could drastically limit recruitment of the prey fish species (Kim and DeVries 2001; Quist *et al.* 2003). Young-of-the-year white crappies feed most heavily during daylight hours on crustacean zooplankton (e.g., copepods and cladocerans) and small dipteran larvae and pupae, but some feeding occurs continuously over a 24-hour period (Siefert 1968, 1969a; Mathur and Robbins 1971; Overmann *et al.* 1980; DeVries *et al.* 1998). Individuals can actively search for, pursue, and capture zooplankton prey down to water temperatures of at least 7°C (O'Brien *et al.* 1986).

The white crappie is adapted behaviorally and visually for detecting zooplankton prey, but foraging success is affected by prey size, prey movement, light intensity, and turbidity. White crappies use a stereotyped saltatory (pause-travel) search strategy in which they visually locate and attack individual prey. In this strategy, they search briefly for a prey item while stationary and, if they do not locate prey, swim a short distance before stopping to scan again (O'Brien 1979; O'Brien *et al.* 1986, 1989; Browman and O'Brien 1992). The white crappie retina has a high density of cones in the far temporal region along the eye's horizontal meridian, an apparent adaptation for detecting open-water zooplankton. Highest probabilities and maximum distances that white crappie will pursue small zooplankters (1–2 mm) are concentrated in a 60-degree forward-directed pie-shaped wedge of limited height (Browman *et al.* 1990) in which the species is better able to discriminate the absolute size of prey (O'Brien *et al.* 1985). The wedge-shaped field of maximum foraging corresponds well with the position of the high-density photoreceptor region on the retina (Browman *et al.* 1990). Under well-lit, low-turbidity conditions (80 lux, 1 NTU), the distance at which individuals (~ 160 mm TL) can detect prey (reactive distance) increases from about 4 to 30 cm as prey size increases from 1 to 3 mm, and reactive distance for moving prey increases about threefold. For 3-mm prey, white crappie reactive distance is little affected by decreases in illumination from 106 to 10 lux, but from 10 lux to 0.97 lux, reactive distance decreases from about 25 to 6 cm. Differences in reactive distance across prey sizes (1–3 mm) at the lowest light intensities are minimal. Reactive distance to a 2.4-mm prey at 80 lux decreases as an approximate log function of turbidity from about 20 cm at 1 NTU to 5 cm at 33 NTU (Wright and O'Brien 1984).

Reproduction: Maturity is usually reached at age 2+ to age 3+ and a minimum size of about 140–180 mm TL, although stunted individuals in dense populations reportedly spawn at 110 mm TL (Morgan 1951a, 1954; Whiteside 1964; Hansen 1951; Siefert 1969a; Trautman 1981). The white crappie is among the earliest, lowest-temperature spawners in the family. The testes and ovaries enlarge and continue developing in the fall and over winter (Morgan 1951b; Whiteside 1964), which is likely an adaptation for early spawning. Spawning occurs at water temperatures of 11 to 27°C with most spawning taking place at 16 to 20°C. The duration of the spawning period is variable, lasting from 17 to 53 days, and depending on latitude, spawning activity occurs from late March to June or mid-July (Hansen 1951; Morgan 1954; Whiteside 1964; Siefert 1969a; Carlander 1977; McDonough and Buchanan 1991; Pope and DeVries 1994; Travnichek *et al.* 1996; Sammons *et al.* 2001). Year-to-year fidelity to nesting areas is not apparent (Hansen 1965). Male white crappies have less fastidious nest-building habits than some centrarchids. Males establish individual territories but apparently do not use caudal sweeping to clear the nesting area. The male remains upright with the abdomen touching or nearly touching the substrate and uses vigorous 3- to 5-second bursts of fin and body movements to sweep out a roughly circular area (about 15–30 cm diameter), actions which remove only the loosest bottom material. Nest-clearing stops before the well-defined depression typical of most centrarchids is created (Hansen 1965; Siefert 1968). Interestingly and atypical among centrarchids, the female often engages in similar nest cleaning behaviors just before spawning and after egg deposition. Substrate at the nest site appears less important to the male than being near some protective cover or bottom vegetation (Siefert 1968). Nests are located on sod clumps, clay, gravel, rock piles, hollows made among aquatic plants, filamentous algae, or roots as well as the surfaces of boulders, rootwads, and submerged brush or trees (Hansen 1943, 1951, 1965; Breder and Rosen 1966). Nests are placed at water depths of 0.1 to 1.5 m (anecdotally up to 6 m, Hansen 1965). Nest spacings suggest colonies (35–50 nests/colony, 46–76 cm apart), and solitary nests are rare (3 of 150), but nests along shorelines (3–15 nests) are in linear arrangements up to 1.2 m apart (Hansen 1965). Nest-guarding males repeatedly repulse approaching females until the female finally stops retreating from the male's territory when chased, and the male accepts the female (Siefert 1968). The female circles the nest alone but ultimately moves over the bottom of the nest in a head-to-head, broadside position with the male. As both quiver and move forward with vents touching, she slides under the male, causing the pair to move in a curve as gametes are released. Each quivering act lasts about 4 seconds with intervals of 30 seconds to 20 minutes, at which time females often leave the nest. Spawning with a single female can continue from 45 minutes to 2.5 hours (Siefert 1968). In spawning pens, one female spawned in the nest of two different males, and on two occasions an intruding male joined a spawning female and guardian male to steal fertilizations (Siefert 1968). Eggs in two distinct stages of development in two nests suggested that multiple spawnings occurred over a 2-day period (Siefert 1968). Male white crappie remain relatively motionless over the nest and apparently do not engage in rim circling, but do display (opercle flare) to neighboring males or rush and attack (butt, snap, bite) territorially intruding males and females (Hansen 1965; Siefert 1968). During incubation, the male fans the eggs with constant motion of the pectoral fins (Hansen 1943; Breder and Rosen 1966). Fertilized eggs, which are almost completely covered with minute debris, often occur in clumps of three or more and are attached to gravel, leaves, twigs, grass, algae, or plants in and well outside the periphery of and even above the nest (Hansen 1943, 1965; Siefert 1968). Mature ovarian eggs are small, ranging from 0.82 to 0.92 mm in diameter, and fertilized water-hardened eggs average 0.89 mm diameter (Hansen 1943; Morgan 1954; Whiteside 1964). Size-adjusted batch fecundities are higher than any other centrarchid except the black crappie (see accounts on *Archoplites* and *Centrarchus*), but female fecundity shows high interannual variation within populations and high variation among populations (Mathur *et al.* 1979; Dubuc and DeVries 2002; Bunnell *et al.* 2005). Some females retain ripe eggs throughout the spawning period (Morgan 1954; Whiteside 1964), and gonadosomatic values and larval densities may each show two or more temporally separate peaks (Dubuc and DeVries 2002), patterns which are suggestive of partial release of a single batch over a protracted period, production of two or more batches by a female, or asynchrony in maturation of females. Fecundity increases with female size. The relationship between number of mature eggs (Y) and TL (X) is described by the function $\log Y = -5.301 + 4.24 \log X$ (formula from data in Morgan 1954, average of 20 length classes, 159–330 mm TL, for 50 females, $R^2 = 0.87$, see also Mathur *et al.* 1979). At a mean size of 230 cm TL, a female potentially can produce 51,609 mature eggs in a single batch (range: 10,787 eggs at 159 cm TL to 238,506 eggs at 330 cm TL). Hatching occurs in 1.8 to 2.1 days at 18.3 to 19.4°C (3.9 days at 14.4°C, about 1 day at 22.8°C) (Morgan 1954; Siefert 1968). Hatchlings are of 1.22 to 2.74 mm TL, and swim-up larvae disperse on average at 4 days post hatch (range: 2.1 to 6.8 days) at a size of 4.1 to 4.6 mm TL (Morgan 1954; Siefert 1968, 1969b; Sweatman and Kohler 1991; Browman and O'Brien 1992). Male parental care from egg deposition to dispersal typically lasts for 6 days, but, on the basis of developmental information, could range from 4 days at 22 to 23°C to 11 days at 14 to 15°C (Siefert 1968). Larvae disperse from nesting areas to forage in open water (Siefert 1969a; Overmann *et al.* 1980).

Nest associates: None known.

Freshwater mussel host: Confirmed host to *A. ligamentina, A. plicata, A. suborbiculata, E. complanata, L. cardium, L. siliquoidea, L. complanata*, and *L. recta* (Young 1911; Lefevre and Curtis 1912; Howard 1914; Coker *et al.* 1921; Barnhart and Roberts 1997). Putative host to *L. reeveiana* (unpublished sources in OSUDM 2006).

Conservation status: The white crappie is secure throughout its native range (Warren *et al.* 2000; NatureServe 2006).

Similar species: The black crappie has a shorter predorsal region, usually 7 to 8 dorsal spines, and no dark bars on sides. These phenotypic characters are not entirely reliable in separating the two crappie species where both species and their hybrids co-occur (Dunham *et al.* 1994; Smith *et al.* 1995).

Systematic notes: *Pomoxis annularis* forms a sister pair with *P. nigromaculatus*. The pair is basal to a clade comprised of the genera *Archoplites* and *Ambloplites* (Roe *et al.* 2002; Near *et al.* 2004, 2005). Comparative studies of variation across the range of *P. annularis* are lacking.

Importance to humans: White crappies are a popular sport fish and like black crappies can maintain recruitment and growth that can sustain extremely high levels of exploitation as sport fisheries (e.g., 60% for age 3 and older fish, Colvin 1991). In southern reservoirs, many thousands of crappies are harvested by anglers in the weeks before spawning when fishes, loosely aggregated near cover, go on a feeding spree, perhaps in response to rising water temperatures or preparatory to spawning (Etnier and Starnes 1993; Allen and Miranda 1996; Miranda and Dorr 2000; Dorr *et al.* 2002). During this time, white crappies are taken easily by anglers using small jigs, streamers, or minnows fished near underwater structure, where fishes are often caught one after the other. Later in spring, white crappies appear most vulnerable to night fishing with minnows below lanterns (Etnier and Starnes 1993).

13.10.2 Pomoxis nigromaculatus *(Lesueur)*

13.10.2.1 Black crappie

Characteristics: See generic account for general characteristics. Deep, extremely compressed body, depth usually 0.37 to 0.45 of SL. Long predorsal region with sharp dip over eye in dorsal profile. Dorsal fin base about equal to or greater than distance from posterior rim of eye to dorsal fin origin. Large, supraterminal, strongly oblique mouth, lower jaw projecting, supramaxilla moderate ($\leq$2 times length of maxilla), upper jaw reaching to or slightly beyond middle of eye. Opercular spot black. Silvery sides profusely speckled and mottled. Long dorsal fin, usually (6)7 to 8(10) spines, 14 to 16 rays; and long anal fin, 6 to 7(8) spines, 16 to 19 rays. Pectoral rays, (13)14(15); vertebrae, 31 to 33(14 + 18 or 19) (Bailey 1938; Keast and Webb 1966; Trautman 1981; Becker 1983; Page and Burr 1991; Etnier and Starnes 1993; Mahee 1993; Jenkins and Burkhead 1994; Smith *et al.* 1995).

Size and age: Typically reach 122 to 160 mm TL at age 1 but first-year growth is highly variable among habitats and apparently less so among latitudes (range, 48–301 mm TL, Carlander 1977). Large individuals measure 300 to 400 mm TL, weigh 400 to 500 g, and reach age 6+ to 8+ (maximum 560 mm TL, 2.72 kg, age 13+) (Carlander 1977; Page and Burr 1991; Etnier and Starnes 1993). World angling record, 2.05 kg, Nebraska and Virginia (IGFA 2006).

Coloration: Gray-green above with upper back and silvery blue sides marked with wavy black lines, dark blotches, and green flecks. Silvery below. Dorsal, anal, and caudal fins with many wavy black bands and pale spots. Males become darker during the breeding season (Page and Burr 1991; Etnier and Starnes 1993; Jenkins and Burkhead 1994). The presence of a black predorsal stripe (colloquially known as the black-nose or black-stripe crappie) in some individuals is the expression of a dominant trait controlled by a single gene (Gomelsky *et al.* 2005).

Native range: The native range presumably includes Atlantic Slope drainages from Virginia to Florida, Gulf Slope drainages west to Texas, and the St. Lawrence River-Great Lakes and Mississippi basins from Quebec to Manitoba and south to the Gulf of Mexico (Page and Burr 1991). The wide introduction and establishment of the black crappie renders accurate determination of the native range difficult (Page and Burr 1991; Fuller *et al.* 1999). As the introduced black crappie became abundant in some California waters, the only native centrarchid, the Sacramento perch, declined or disappeared (Moyle 2002). Historical shifts in distribution and relative abundance suggest that the black crappie has declined or has been replaced by the white crappie because of increased turbidity of waters (e.g., South Dakota, Carlander 1977; Illinois, Smith 1979; Ohio, Trautman 1981; Wisconsin, Becker 1983). In some reservoirs, the black crappie hybridizes extensively with the white crappie (see account on *P. annularis*).

Habitat: The black crappie inhabits lakes, ponds, sloughs, and backwaters and pools of streams and rivers. The species is most common in lowland habitats, large reservoirs, and navigation pools of large rivers but is rare in upland rivers and streams. The black crappie is usually associated with clear waters, absence of noticeable current, and abundant cover (e.g., aquatic vegetation, submerged timber) (Carlander 1977; Werner *et al.* 1977; Conrow *et al.* 1990; Page and Burr 1991; McDonough and Buchanan 1991; Keast and Fox 1992; Etnier and Starnes 1993; Pflieger 1997). The species is apparently moderately tolerant of oligohaline conditions, occasionally entering tidal waters (usually <5.0-ppt salinity) to feed on small fish and shrimp (Rozas and Hackney 1984; Moyle 2002). In a whole-lake acidification experiment, black crappies nested from pH 5.6 to 4.7, but no larvae or post larvae were observed at pH 4.7 (Eaton *et al.* 1992; see also McCormick *et al.* 1989). Along a bog lake successional gradient in Wisconsin, the species was rare or absent in lakes with pH <6.0 (Rahel 1984). Field and laboratory observations indicate that the black crappie is tolerant of long exposures to extremely low temperatures (<1°C) and DO (ca. 1 ppm), particularly in winter (e.g., Cooper and Washburn 1946; Moyle and Clothier 1959; Siefert and Herman 1977; Carlson and Herman 1978; Knights *et al.* 1995).

Black crappies move to shift seasonal habitats or track resources, to avoid extreme physical conditions, and in response to environmental changes. In the St. Johns River, Florida, 38% of recaptured individuals emigrated at least 5 km from the point of capture, and three fish traveled over 99 km (Snyder and Haynes 1987 in Parsons and Reed 2005). In a series of small, interconnected glacial lakes, up to 92% of recaptured black crappies had emigrated from the lake of origin to another lake (Parsons and Reed 2005). In Wisconsin, radio-tagged black crappies moved among a series of small, shallow finger lakes to overwinter in oxygenated refuges that were distinct from summer and fall activity areas. Individuals avoided areas with DO concentrations <2 mg/l despite physiological advantages of warmer water temperatures (>1°C) and lower currents in those areas (Knights *et al.* 1995). In a South Dakota lake, mean movement in spring and summer was highest in April and July (about 130 m/h), and highest diel movement was at night and early morning. Increased movement also was correlated highly with increased barometric pressure (Guy *et al.* 1992).

Food: The black crappie is primarily a midwater invertivore, usually shifting to piscivory at a relatively late age and large size compared to other piscivorous centrarchids (up to age 3+ in northern populations) (Seaburg and Moyle 1964; Keast and Webb 1966; Keast 1985c). A variety of fishes (e.g., centrarchids, minnows, yellow perch, clupeids), aquatic insects (e.g., chironomid, mayfly, and odonate larvae), and crustaceans (e.g., amphipods, freshwater shrimp) usually dominate diets of the largest individuals (>160 mm TL). Winged insects are occasionally taken in the summer months (McCormick

1940; Reid 1950b; Seaburg and Moyle 1964; Keast and Webb 1966; Keast 1968a, 1985c; Ball and Kilambi 1972; Becker 1983; Ellison 1984; Keast and Fox 1992; Liao *et al.* 2002). The zooplankton-dominated diet of young black crappie can be continued until individuals reach a relatively large size (160–200 mm TL), a feeding strategy likely associated with the possession of numerous, long gill rakers (Keast and Webb 1966; *et al.*Keast 1968a, 1980, 1985c; Bulkley *et al.* 1976; Overmann *et al.* 1980; Ellison 1984; Hanson and Qadri 1984; Schael *et al.* 1991; Pope and Willis 1998; Pine and Allen 2001; Dubuc and DeVries 2002; see account on *P. annularis*). Young-of-the-year tend toward diurnal or crepuscular feeding, but both adults and young may feed at virtually any hour of the day or night. Large black crappies are one of the most active nocturnal feeders among centrarchids; during the day, individuals may remain in the same location for several hours or all day. Peak movement and feeding occur at dawn or dusk, but movement and feeding also peak at night (Childers and Shoemaker 1953; Keast 1968a; Helfman 1981; Ellison 1984; Guy *et al.* 1992; Keast and Fox 1992; Shoup *et al.* 2004). Black crappies often exploit small dipteran larvae (*Chaoborus*) and pupae (*Chironomus*) as these insects rise in the water column at dusk and night (Keast 1968a; Keast and Fox 1992). Individuals tend to move to deeper offshore waters during the day and shallower depths or inshore waters at night, presumably to feed, but the extent of these movements and movement patterns varies seasonally (Helfman 1981; Guy *et al.* 1992; Keast and Fox 1992). The black crappie can feed actively at water temperatures as low as 6.5°C (Keast 1968b).

Reproduction: Maturity is reached at age 2+ to 4+ and a minimum size of about 178 mm TL (Huish 1954; Cooke *et al.* 2006). Most nesting and spawning occur at water temperatures of 14 to 22°C (to 26°C) with peak activity (most active nests) at about 18°C (Carlson and Herman 1978; Becker 1983; Colgan and Brown 1988; Pine and Allen 2001; Cooke *et al.* 2006). Spawning is most protracted in Florida, occurring over a 12-week period from late January to May with peaks in March and April. The spawning season is later (April to June or even July in northern lakes) and shorter (21 to 37 days) at more northerly latitudes (Reid 1950b; Huish 1954; Becker 1983; Keast 1985c; Pope *et al.* 1996; Travnichek *et al.* 1996; Pope and Willis 1998; Pine and Allen 2001; Cooke *et al.* 2006). The ovaries enlarge and continue developing in the fall and over winter (Schloemer 1947; Morgan 1951a), which is likely an adaptation for early spring spawning. In South Dakota waters, male black crappies move 0.4 to 6.0 km to establish spawning sites (Pope and Willis 1997). In the spawning area, the male establishes a territory and prepares a saucer-shaped depressional nest (20 to 23 cm diameter) in variable substrates (gravel, sand, clay, or even softer) and water depths (0.25 to 6.1 m). Nests are placed in areas protected from wind and waves, usually at the base of vegetation (e.g., cattails), near the edge of floating or emergent plant beds, or near other simple cover (e.g., logs) (Reid 1950b; Carlander 1977; Siefert and Herman 1977; Pope and Willis 1997). Nests may be closely spaced (3.3 nests/m^2) or more loosely aggregated (1.8 m apart) (Breder and Rosen 1966; Carlander 1977; Becker 1983). Reproductive behaviors are presumably similar to those of the white crappie, but little detail is available for comparison. In experimental tanks with two nesting males, females on occasion spawned with both males and in one instance, a male spawned with two females (Siefert and Herman 1977). Eggs are demersal, adhesive, and whitish to yellowish in color (Scott and Crossman 1973; Barwick 1981). Mature ovarian eggs range from 0.68 to 1.05 mm diameter, water-hardened eggs average 0.93 mm diameter (range: 0.7591–1.03 mm), and water-hardened, fertilized eggs average 1.27 mm diameter (Merriner 1971a; Barwick 1981; Cooke *et al.* 2006). Size-adjusted batch fecundities are higher than any other centrarchid except the white crappie (see accounts on *Archoplites* and *Centrarchus*), but female fecundity can be highly variable between years or among populations (Dubuc and DeVries 2002). One to three distinct size classes of maturing ova are reported in ovaries of mature females, suggesting that some females may produce multiple batches of eggs (Barwick 1981; Pope *et al.* 1996). In controlled settings, the number of eggs released per spawn (average 66,130/243 mm TL female; Siefert and Herman 1977) falls within the range estimated for a 246 mm TL female (see subsequent), suggesting single-batch production. Fecundity increases with female size. The relationship between number of mature eggs (Y) and TL (X) is described by the power functions $\log Y = -3.0196 + 3.243 \log X$ and $\log Y = -6.2192 + 4.6580 \log TL$ (formulas from Barwick 1981, n = 59, $R^2 = 0.57$, and Baker and Heidinger 1994, n = 11, $R^2 = 0.74$, respectively). At a mean size of 246 mm TL, a female potentially can produce 54,225 to 82,751 mature eggs in a single batch (range: 10,836–13,168 eggs at 159 mm TL to 143,368–334,396 eggs at 332 mm TL). Hatching occurs in 2.4 days at 18.3°C, newly hatched larvae are 2.3 mm TL, and swim-up larvae are about 4 to 5 mm TL (Merriner 1971b; Siefert 1969b; Bulkley *et al.* 1976; Chatry and Conner 1980; Brown and Colgan 1985b). Black crappie maintained overwinter at DO concentrations as low as 2.6 mg/l successfully spawned (larvae survived to swim-up) during a simulated spring-to-summer rise in temperature (Carlson and Herman 1978). Spawning did not occur in trials with constant DO of 1.8 mg/l or diurnally fluctuating levels of 1.8 to 4.1 mg/l. No differences in number of embryos, hatching success, or survival through swim-up were detected at DO levels as low as 2.5 mg/l, but at that level individuals started and finished spawning earlier (i.e. at lower temperatures) than those exposed to higher DO concentrations (Siefert and Herman 1977). The male vigorously guards the nest, eggs, and larvae from predation by frequent nest predators, especially *Lepomis* spp. At the northern edge of the range, the entire cycle of male parental care lasts for about 7 to 11 days from egg deposition until swim-up larvae disperse (Colgan and Brown 1988; Cooke *et al.* 2006). The male feeds opportunistically during this period on invertebrates occurring on vegetation near the nest (e.g., amphipods) (Reid 1950b; Colgan and Brown 1988; Breder and Rosen 1966).

Nest associates: None known.

Freshwater mussel host: Confirmed host to *A. ligamentina, A. plicata, A. ferussacianus*, and *L. siliquoidea* (Howard 1914, 1922; Coker *et al.* 1921; Hove *et al.* 1997). Putative host to *L. compressa* (unpublished sources in OSUDM 2006).

Conservation status: The black crappie is secure throughout its native range (Warren *et al.* 2000; NatureServe 2006).

Similar species: The white crappie has a longer predorsal region, usually six dorsal spines, and vague but usually discernible dark bars on sides (see account on white crappie).

Systematic notes: *Pomoxis nigromaculatus* forms a sister pair with *P. annularis* (see account on *P. annularis*). Comparative analyses across the range of the species are lacking.

Importance to humans: Catchability, edibility, and liberal catch limits in most waters make the black crappie a highly sought and important sport fish throughout its rather large range. The species is easily caught on minnows, worms, and a variety of artificial lures; dry flies are taken occasionally. Black crappies tend to aggregate and at dusk are often caught one after the other as quickly as the hook can be rebaited. Because it remains active in cold waters, the species is also a popular target for ice fishing enthusiasts (Scott and Crossman 1973; Becker 1983). The flesh is white, flaky, and tasty, comparing favorably as table fare with the highly acclaimed walleye (*Sander vitreum*) (Scott and Crossman 1973; Becker 1983).

13.11 Identification keys to genera and species

Dichotomous keys are presented for identification of genera within the family and species within each genus. The characters used primarily follow and are illustrated in Becker (1983), Page and Burr (1991), Etnier and Starnes (1993), Jenkins and Burkhead (1994), Pflieger (1997), Ross (2001), Boschung and Mayden (2004), Marcy *et al.* (2005), and other taxa-specific sources given in the generic and species accounts. The species keys here are aimed primarily at identifying adults. Young individuals of many centrarchids can be a challenge to correctly identify to species, but illustrations and characters useful in differentiating juveniles are available in Ramsey and Smitherman (1972), Etnier and Starnes (1993), and Jenkins and Burkhead (1994).

13.11.1 Key to genera of Centrarchidae

1a. Anal fin with 4 to 5 or more spines.

Go to 2

1b. Anal fin with 3 spines.

Go to 6

2a. Anal fin base shorter than dorsal fin base; anal fin with 12 or fewer soft rays; moderately laterally compressed to elongate body.

Go to 3

2b. Anal fin base about equal to dorsal fin base; anal fin with 13 or more soft rays; deep, laterally compressed body.

Go to 5

3a. Caudal fin bilobed or concave; scales ctenoid; gill rakers long or moderately long, 7 or more on first arch.

Go to 4

3b. Caudal fin rounded; scales cycloid (scale shape percoid-like with anterior margin truncate and scalloped but ctenii are lacking); gill rakers moderately long, stout, 5 to 7 on first arch.

Acantharchus pomotis, mud sunfish

4a. Red eye in life. Gill rakers moderately long, 7 to 16 on first arch; branchiostegal rays usually 6. Dorsal fin with 10 to 12 spines, 11 to 12 rays; anal fin with 5 to 7 spines, 10 to 11 rays.

Ambloplites

4b. Eye not red in life. Gill rakers long, slender, 25 to 29 on first arch; branchiostegal rays usually 7. Dorsal fin with 12 to 14, usually 13 spines, 10 to 12 rays; anal fin with 6 to 8, usually 7 spines, 10 to 12 rays.

Archoplites interruptus, Sacramento perch

5a. Dorsal fin with 5 to 8 spines, 14 to 16 rays; anal fin with 6 spines, 17 to 19 rays; no teardrop; laterally compressed oblong body; rounded pectoral fin.

Pomoxis

5b. Dorsal fin with 11 to 13 spines, 12 to 15 rays; anal fin with 7 to 8 spines, 13 to 17 rays; large black teardrop; short, deep extremely laterally compressed body; long, pointed pectoral fin.

Centrarchus macropterus, flier

6a. Body elongate, depth goes into SL three or more times; lateral scale rows 55 or more; dorsal fins nearly separate, deeply notched.

Micropterus

6b. Body deeper, laterally compressed, depth goes into SL less than three times; lateral scale rows less than 55; dorsal fins continuous.

Go to 7

7a. Caudal fin truncate or rounded, not concave or bilobed; black teardrop.

Enneacanthus

7b. Caudal fin concave or bilobed; no black teardrop.

Lepomis

13.11.2 Key to species of Ambloplites

1a. Cheek naked or partly scaled, if present cheek scales are tiny or small and deeply embedded; body often with distinct round pale spots (iridescent gold to white in life) on upper side and head (found only in the Roanoke, Tar, and Neuse river drainages of Virginia and North Carolina).

Ambloplites cavifrons, Roanoke bass

1b. Cheek fully scaled, the scales moderate to large size and only slightly to moderately embedded; body lacking distinct pale spots.

Go to 2

2a. Color pattern of sides of body dominated by freckled pattern (scattered dark brown spots); no black edge on anal fin of large male (found only in the White River basin, Arkansas and Missouri, and Sac and Pomme de Terre drainages of the Osage River basin).

Ambloplites constellatus, Ozark bass

2b. Sides lack freckled pattern but are dominated by regularly arranged horizontal rows of brown-black spots or broad irregular vertical dark blotches; distinctive black edge on anal fin of large male, present or absent.

Go to 3

3a. Color pattern of sides of juveniles and adults dominated by broad irregular vertical brownish or grayish blotches; large male lacks black edged anal fin; breast scale rows (between bases of pectoral fins) usually $\leq$20.

Ambloplites ariommus, shadow bass

3b. Color pattern of sides of adults dominated by regularly arranged horizontal rows of brown-black spots (young patterned similar to *A. ariommus*); large male with distinctive black edge on anal fin; breast scale rows (between bases of pectoral fins) usually 21 to 25.

Ambloplites rupestris, rock bass

13.11.3 Key to species of Enneacanthus

1a. Six distinct bold black bars on sides contrast with pale to opalescent ground color, often with rose or pink blush; first bar on head passes through eye, forming a distinct black teardrop; the third black bar, extending from the anterior dorsal fin to the pelvic fin forms a distinct black blotch on the first 2 to 3 anterior membranes of the spiny dorsal fin; sixth bar on caudal peduncle is often faint; 3 to 4 incomplete bars often occur between complete bars; juncture of spiny and soft dorsal fin noticeably notched; second dorsal and anal fin not enlarged in breeding male.

Enneacanthus chaetodon, blackbanded sunfish

1b. Sides of body lack distinct bold black vertical bars on light background (may have dark to faint bars on dusky background); anterior dorsal fin membranes lack distinct black blotch, fin membranes mostly with uniformly dusky or dark pigmentation with rows of pale spots in soft-rayed portion; dorsal fin smooth in profile, not deeply notched; second dorsal and anal fins enlarged in breeding male.

Go to 2

2a. Body side pattern of males dominated by 5 to 8 dark to faint vertical bars (darkest on large individuals); rows of greenish-copperish to purple-gold crescent-shaped spots along side; black spot on ear tab larger than eye pupil; usually 19 to 22 scales around caudal peduncle

Enneacanthus obesus, banded sunfish

2b. Body side pattern of large young and adults dominated by rows of iridescent blue, silver, or pale round spots; bars on sides indistinct in adults; black spot on ear tab two-thirds the size of eye pupil; usually 16 to 18 scales around caudal peduncle.

Enneacanthus gloriosus, bluespotted sunfish

13.11.4 *Key to species of* Pomoxis

1a. Dorsal fin base shorter than distance from eye to dorsal fin origin; dorsal spines, usually 5 to 6; cheek scale rows, usually 4 to 5; mottling on sides forming 8 to 10 dark, irregular, but discernible, vertical bars.

Pomoxis annularis, white crappie

1b. Dorsal fin base about as long as distance from eye to dorsal fin origin; dorsal spines, usually 7 to 8; cheek scale rows, usually 6; sides randomly mottled with dark pigment (may be vertically barred in young).

Pomoxis nigromaculatus, black crappie

13.11.5 *Key to species of* Lepomis

1a. Sensory pits on top of head between eyes greatly enlarged, their width about equal to distance between them; sensory pores on edge of opercle greatly elongated, slit-like; ear flap, elongate, flexible, angled upward, black with wide white edge; gill rakers, long, slender, length of longest about 4 to 5 times their basal width.

Lepomis humilis, orangespotted sunfish

1b. Sensory pits between eyes not greatly enlarged, their width much less than the distance between them; sensory pores on edge of preopercle, not slit-like; ear flap size, orientation, and pigmentation variable; gill rakers variable.

Go to **2**

2a. Pectoral fins long and moderately sharply pointed, extending to or beyond anterior rim of eye when bent forward.

Go to **3**

2b. Pectoral fins shorter with tips rounded, not extending to anterior rim of eye when bent forward.

Go to **5**

3a. Large dark spot at rear of dorsal fin (faint in young); ear flap black to margin; gill rakers long, slender, length of longest four or more times their basal width; dark bars on sides (absent in turbid water; thin and chainlike in young).

Lepomis macrochirus, bluegill

3b. No dark spot at rear of dorsal fin; sides usually with scattered dark spots (may form single vertical bars in young); ear flap with pale margin or spot at tip; gill rakers short, longest about two times longer than basal width.

Go to **4**

4a. Pectoral fins long, extending to about 3 to 5 scale rows below dorsal fin base when angled upward; second dorsal fin with many bold dark brown wavy lines and spots; wavy blue lines on cheek and opercle of adult; sides below lateral line marked with dusky spots (orange in life); body of adults deep, depth about 0.5 of SL; profile of head in adults rounded.

Lepomis gibbosus, pumpkinseed

4b. Pectoral fins very long, extending to or beyond dorsal fin base when angled upward; second dorsal fin uniform or with vague dark mottling but lacks bold wavy lines or spots; no blue lines on cheek and opercle; sides below lateral line uniformly pigmented, not marked with dusky spots; body of adults somewhat elongate, depth about 0.4 of SL in adults; profile of head more or less pointed.

Lepomis microlophus, redear sunfish

5a. Tooth patch on tongue; 3 to 4 dark bars (red-brown in life) radiating backward from eye across cheeks and opercles.

Lepomis gulosus, warmouth

5b. No tooth patch on tongue; no dark bars radiating backward from eye.

Go to 6

6a. Lateral line incomplete or interrupted; gill rakers long, slender, longest 6 to 8 times longer than their basal width; dark spot usually at rear of soft dorsal fin (indistinct in large specimens); coloration relatively subdued, dusky, no bright blue, red, orange, or yellow colors on head or body; small, adults usually <75 mm SL.

Lepomis symmetricus, bantam sunfish

6b. Lateral line complete, not interrupted (occasionally interrupted in *Lepomis peltastes*, which has short, stubby gill rakers and wavy blue lines on cheek and opercle); dorsal spot variable; coloration variable.

Go to 7

7a. Mouth relatively large and moderately oblique, the upper jaw extending well past anterior rim of eye in large specimens.

Go to 8

7b. Mouth relatively small and moderately to very oblique, the upper jaw seldom extending past anterior rim of eye.

Go to 9

8a. Ear flap short, the black portion inflexible and appearing as a round spot, posterior edges pale; large dark spot usually evident at rear of dorsal and anal fins; gill rakers long and slender, length of longest 4 to 6 times their basal width; lateral scales, usually 45 to 50; scales below lateral line, usually 16 to 19; body relatively elongate, robust, and basslike.

Lepomis cyanellus, green sunfish

8b. Ear flap long, narrow, and flexible in adults, black to posterior margin, outlined above and below by pale or blue lines; no large dark spot at rear of dorsal or anal fin; gill rakers moderate, length of longest two times basal width in adults; lateral scales, usually 41 to 50; scales below lateral line, usually 14 to 16; body deep, not basslike.

Lepomis auritus, redbreast sunfish

9a. Ear flap, elongate, thin, and flexible; wavy blue to blue-green lines on cheek and opercle in life; gill rakers, short, stubby, knoblike, length of longest about equal to their basal width in adults.

Go to 10

9b. Ear flap short, stiff; no wavy blue lines on cheek and opercle; gill rakers not stubby or knoblike, moderate to long, length of longest about two to six times their basal width.

Go to 12

10a. Ear flap with black center, bordered in pale to white, angled upward at about 45 degrees and in adult males posterior edge marked with red spot; lateral scales, usually 35 to 37; pectoral rays, usually 12 to 13 (found only in Great Lakes basin and a few scattered localities in the upper Mississippi basin).

Lepomis peltastes, northern longear sunfish

10b. Ear flap, variously oriented, with black center and pale to white borders, but lacks distinct posterior red spot (not found in Great Lakes basin).

Go to 11

11a. Cheek scales, usually 3 to 4; pectoral rays, usually 12 to 13; ear flap often angled noticeably upward, center black and often flecked with silver or greenish streaks, margin pale white to greenish; lateral line brick red in life; blue-green marks (brown in preserved fish) on lower side of head tend to be broken, appearing as freckles or short streaks; body profile somewhat rounded, greatest depth usually beneath or behind the dorsal fin origin.

Lepomis marginatus, dollar sunfish

11b. Cheek scales, usually 5 to 6; pectoral rays, usually 13 to 14; ear flap orientation variable, usually horizontal or angled slightly upward, center black, entire margin whitish, flushed with orange-red, or with 2 to 9 red spots scattered along the margin (some populations lack pale margins); lateral line not red in life; blue-green marks (brown in preserved fish) on lower side of head tend to form long continuous streaks; body profile more elongate, the greatest depth usually before the dorsal fin origin in specimens <150 mm SL.

Lepomis megalotis, longear sunfish

12a. Discrete black spots on scales form irregular horizontal rows of spots on sides and dorsum, especially prevalent on lower sides; cheek and opercle often speckled with small discrete dark spots; breeding males lack red-orange on breast, belly, and on sides (these may be yellowish to pinkish); breast scale rows, usually 15 to 18; cheek scales, usually 5 to 7; scales above lateral line, usually, 7 to 8; scales below lateral line, 13 to 15; caudal peduncle scales, usually 8 to 10.

Lepomis punctatus, spotted sunfish

12b. Pale areas (red-orange in breeding males) at anterior scale bases form horizontal rows of triangular-shaped spots along sides; discrete black spots lacking at scale bases; cheek and opercle lack speckling of small discrete dark spots (often with a few dusky to dark streaks); breeding males with red-orange color on sides, breast, belly, dorsal margin of ear tab, and quadrate patch on side above ear tab; breast scales, usually 12 to 15; cheek scales, usually 4 to 6; scales above lateral line, usually, 6 to 7; scales below lateral line, 12 to 14; caudal peduncle scales, usually 7 to 9.

Lepomis miniatus, redspotted sunfish

13.11.6 Key to species of Micropterus

1a. Spinous and soft dorsal fins separated by deep notch, if connected, only by a small membrane; length of last dorsal spine less than half the length of longest dorsal spine; upper jaw extends beyond posterior rim of eye in adults; dark lateral band present; caudal fin of juveniles bicolored, the base lighter than posterior portion; pyloric caeca branched at base.

Go to **2**

1b. Dark lateral band present or absent, sides often marked by conjoined blotches or vertically elongate bars; spinous and soft dorsal fins well connected, the notch between the fins shallow; length of last spine more than half the length of longest spine; upper jaw usually not extending beyond posterior rim of eye; caudal fin of juveniles tricolored, often sharply contrasted dark middle region separating orange or yellow base from white (or clear) posterior (faint to lacking in *M. coosae*), with or without prominent tail spot; pyloric caeca unbranched.

Go to **3**

2a. Lateral scales, usually 69 to 73; caudal peduncle scales, usually 28 to 31 scales (occurs as a native only in peninsular Florida, but widely introduced in the southern United States)

Micropterus floridanus, Florida bass

2b. Lateral scales, usually 58 to 67; caudal peduncle scales, usually 26 to 28.

Micropterus salmoides, largemouth bass

3a. Side uniformly pigmented or with series of broad, indistinct vertical bars, lower sides without distinct rows of horizontal spots, juveniles lack a distinct black caudal spot; scales above lateral line, usually 12 to 13; scales below the lateral line, usually 19 to 23.

Micropterus dolomieu, smallmouth bass

3b.. Side with a distinct narrow midlateral horizontal band (or series of partly joined quadrate blotches) or a midlateral band consisting of a series of vertically elongate blotches (may be indistinct); juveniles may or may not have a distinct caudal spot; scales above lateral line, usually 6 to 9; scales below lateral line, usually <20.

Go to 4

4a. Side with a dark, usually distinct and narrow, midlateral horizontal stripe (or series of partly joined blotches, not elongated vertically) and lower sides with rows of small black spots; middle band on caudal fin and black caudal spot of juveniles distinct; tooth patch on tongue.

Micropterus punctulatus, spotted bass

4b. Side with a series of vertically elongate to quadrate blotches (often indistinct or faint in adults).

Go to 5

5a. Caudal fin orange with white (or clear) upper and lower outer edges; tail spot prominent in juveniles; tooth patch on tongue; sides marked with dark confluent irregular blotches or stripe; tinges of red or orange on fins; young lacking sharply contrasting caudal fin pigmentation; 5 to 8 well-developed rows of dark spots on ventrolateral scales.

Micropterus coosae, redeye bass

5b. Caudal fin without white (or clear) upper and lower outer lobes; tooth patch on tongue present or absent.

Go to 6

6a. No tooth patch on tongue; sides marked with 10 to 15 dark vertically elongate midlateral bars with 6 to 8 supralateral bars extending into the interspaces of the midlateral bars; 5 to 7 rows of weakly developed spots on ventrolateral scales, frequently forming wavy lines; quadrate to rectangular dark tail spot in adults, lacking or faint in young; caudal peduncle scales, usually 30 to 33; lateral line scales, usually 72 to 77 (found as native only in the Apalachicola River system, Alabama and Georgia).

Micropterus cataractae, shoal bass

6b. Tooth patch on tongue; sides variously marked; caudal peduncle scales, usually <31; lateral line scales, usually <69.

Go to 7

7a. Upper jaw extending to or beyond rear margin of eye in adults; sides marked with a series of about 12 vertically elongate lateral blotches, anteriorly much wider than interspaces, fusing on the caudal peduncle, to form a relatively uniform lateral band; caudal spot prominent in young; caudal peduncle scales, usually 27 to 31; lateral line scales, usually 57 to 65 (found as native only in Suwannee and Ochlockonee river systems, Florida).

Micropterus notius, Suwannee bass

7b. Upper jaw extending to or slightly beyond middle of eye; sides marked with a series of about 13 vertically elongate lateral blotches, being broadly diamond shaped, especially on the caudal peduncle; dark spots on scales form distinct continuous lines on lower sides; caudal spot prominent in young; caudal peduncle scales, usually 26 to 27; lateral line scales, usually 61 to 69 (found only on the Edwards Plateau of Texas in the Brazos, Colorado, Guadalupe, and San Antonio rivers and upper Nueces River, where introduced).

Micropterus treculi, Guadalupe bass

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Centrarchidae Species List with Latin Name and Common Name

Acantharchus pomotis, mud sunfish
Ambloplites ariommus, shadow bass
Ambloplites cavifrons, Roanoke bass
Ambloplites constellatus, Ozark bass
Ambloplites ruprestris, rock bass
Archoplites interruptus, Sacramento perch
Centrarchus macropterus, flier
Enneacanthus chaetodon, blackbanded sunfish
Enneacanthus gloriosus, bluespotted sunfish
Enneacanthus obesus, banded sunfish
Pomoxis annularis, white crappie
Pomoxis nigromaculatus, black crappie
Lepomis auritus, redbreast sunfish
Lepomis cyanellus, green sunfish
Lepomis gibbosus, pumpkinseed
Lepomis gulosus, warmouth
Lepomis humilis, orangespotted sunfish
Lepomis macrochirus, bluegill
Lepomis morginatus, dollar sunfish
Lepomis megalotis, longear sunfish
Lepomis microlophus, redear sunfish
Lepomis miniatus, redspotted sunfish
Lepomis peltastes, northern longear sunfish
Lepomis punctatus, spotted sunfish
Lepomis symmetricus, bantam sunfish
Micropterus henshalli, Alabama bass*
Micropterus cataractae, shoal bass
Micropterus coosae, redeye bass
Micropterus dolomieu, smallmouth bass
Micropterus floridanus, Florida largemouth bass
Micropterus notius, Suwannee bass
Micropterus punctulatus, spotted bass
Micropterus salmoides, largemouth bass
Micropterus treculi, Guadalupe bass

*Note: *M. henshalli* (Alabama bass) was elevated to the species level in 2008 when this book was "in press". Hence, in this book and index it is referred to as a subspecies of *M. punctulatus* (spotted bass).

Index

Note: Only Latin binomials have been used here. Please consult the previous page for a complete species list with common names cross-referenced with Latin binomials.

From: Melissa Samet <sametm@nwf.org>
Sent: Tuesday, August 27, 2024 6:26 PM
To: YazooBackwater MVK
Subject: [Non-DoD Source] Conservation Organization Yazoo Pumps Comments: Email 4 of 4
Attachments: Conservation Organization Comments_Yazoo Pumps DEIS_Attachments G, H, I, J.pdf

Importance: High

Please see attachment E to the comments on the Yazoo Pumps Draft EIS from the National Wildlife Federation, National Audubon Society, Sierra Club, Audubon Delta, Healthy Gulf, and Mississippi Chapter of the Sierra Club.

Due to the large file size of the attachments, I am sending the text of the comments and the Attachments in 4 separate emails. This is email 4 of 4.

I would very much appreciate you confirming receipt of each of the 4 emails.

Thank you

Melissa Samet
Legal Director, Water Resources and Coasts
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(o) 415-762-8264
(c) 415-577-9193
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Attachment G

Comments on the Draft Environmental Impact Statement for the Yazoo Backwater Area Water Management Project, June 2024

Submitted by

National Wildlife Federation, National Audubon Society, Sierra Club
Audubon Delta, Healthy Gulf, Sierra Club Mississippi

August 27, 2024

Ongoing declines for the world's amphibians in the face of emerging threats

https://doi.org/10.1038/s41586-023-06578-4
Received: 16 January 2023
Accepted: 25 August 2023
Published online: 4 October 2023
Open access
Check for updates

Systematic assessments of species extinction risk at regular intervals are necessary for informing conservation action[1,2]. Ongoing developments in taxonomy, threatening processes and research further underscore the need for reassessment[3,4]. Here we report the findings of the second Global Amphibian Assessment, evaluating 8,011 species for the International Union for Conservation of Nature Red List of Threatened Species. We find that amphibians are the most threatened vertebrate class (40.7% of species are globally threatened). The updated Red List Index shows that the status of amphibians is deteriorating globally, particularly for salamanders and in the Neotropics. Disease and habitat loss drove 91% of status deteriorations between 1980 and 2004. Ongoing and projected climate change effects are now of increasing concern, driving 39% of status deteriorations since 2004, followed by habitat loss (37%). Although signs of species recoveries incentivize immediate conservation action, scaled-up investment is urgently needed to reverse the current trends.

The International Union for Conservation of Nature (IUCN) Red List Index (RLI) documents the extinction risk trends of species groups over time[5], generating information that is crucial for conservation prioritization and planning[6]. The landmark 2004 Global Amphibian Assessment (GAA1) was published on the IUCN Red List, demonstrating that amphibians were the most threatened class of vertebrates worldwide, and has been widely used to guide and motivate amphibian conservation efforts[7]. The 2004 baseline study identified habitat loss and degradation and over-exploitation as the main threats, contributing to the deterioration of just over half of the species that deteriorated in status between 1980–2004, while 48% were classified as enigmatic-decline species[7]. Subsequent studies support that the disease chytridiomycosis, caused by *Batrachochytrium dendrobatidis*, was most likely responsible for many enigmatic declines[8–12]. The GAA1 helped to launch a wave of research and conservation efforts directed at *B. dendrobatidis* and the other threats causing the decline in amphibians[6].

Completed in June 2022, the second Global Amphibian Assessment (GAA2) reassessed the status of the GAA1 species and added 2,286 species, bringing the number of amphibians on the IUCN Red List to 8,011 (39.9% increase from 2004; covering 92.9% of 8,615 described species). Since the GAA1, information on population trends, ecological requirements, threats and distributional boundaries of amphibians has improved considerably, and amphibian systematics have progressed. However, this new information (for example, better estimates of population size, redefining taxonomic boundaries) can sometimes result in a non-genuine change in Red List category, introducing biases in the data. We therefore used current information to estimate a backcasted Red List category for each species in 1980 and 2004 and examine only genuine category changes. With these data and the GAA2 assessments, we re-examine the global status and trends of amphibians and present new insights on threats, providing a crucial update that informs the prioritization, planning and monitoring of conservation actions.

Threatened and extinct species

The status of amphibians worldwide continues to deteriorate: 40.7% (2,873) are globally threatened (that is, IUCN Red List categories Critically Endangered, Endangered and Vulnerable), compared with 37.9% (2,681) in 1980 and 39.4% (2,788) in 2004 (Fig. 1 and Extended Data Table 1; see the 'Percentage of threatened species' section of the Methods). The proportion of species in the Data Deficient IUCN category has decreased from 22.5% in the GAA1 to 11.3% as a result of newly available information.

The greatest concentrations of threatened species are in the Caribbean islands, Mesoamerica, the Tropical Andes, the mountains and forests of western Cameroon and eastern Nigeria, Madagascar, the Western Ghats and Sri Lanka. Other notable concentrations of threatened species occur in the Atlantic Forest biome of southern Brazil, the Eastern Arc Mountains of Tanzania, central and southern China, and the southern Annamite Mountains of Vietnam (Fig. 1). Of all of the comprehensively assessed groups on the IUCN Red List, amphibians are the second most threatened group and remain the most threatened vertebrate class (cycads, 69%; sharks and rays, 37.4%; conifers, 34.0%; reef-building corals, 33.4%; mammals, 26.5%; reptiles, 21.4%; dragonflies, 16%; birds, 12.9%; cone snails, 6.5%)[13–19].

Documented amphibian extinctions continue to increase: there were 23 by 1980, an additional 10 by 2004 and four more by 2022, for a total of 37 (Extended Data Table 1). The most recent are *Atelopus chiriquiensis* and *Taudactylus acutirostris*, after rapid declines linked to chytridiomycosis in the 1990s, while *Craugastor myllomyllon* and *Pseudoeurycea exspectata* were last seen in the 1970s and are believed to be Extinct due to agricultural expansion. Strict requirements must be met to declare a species Extinct[20]; therefore, many species missing for decades are categorized as Critically Endangered (CR) and tagged as Possibly Extinct (CR(PE)). For 1980, 24 amphibians were categorized as CR(PE), for 2004 this increased to 162, with another 23 added for 2022 (Extended Data Table 1). Thus, the number of known amphibian

A list of authors and their affiliations appears at the end of the paper.

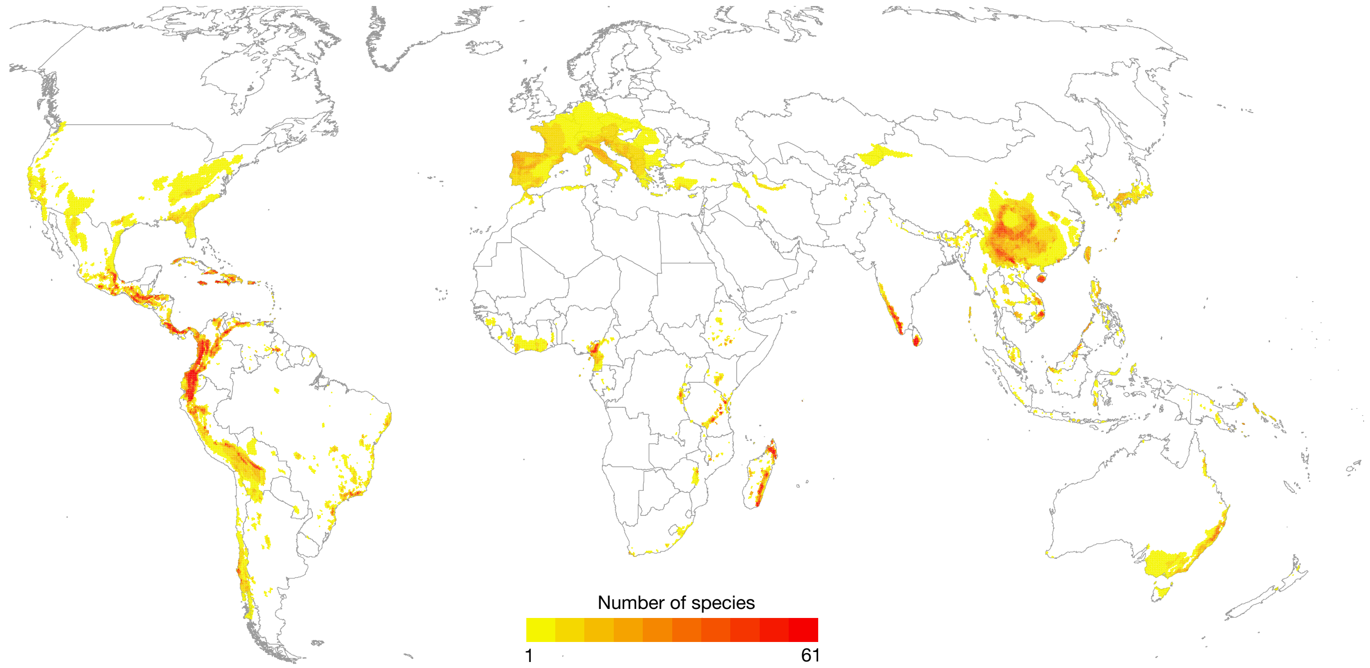

Fig. 1 | The distribution of 2,873 globally threatened amphibian species. The darker colours correspond to higher species richness. The colour scale is based on 10 quantile classes. Maximum richness equals 61 species. The cell area is 865 km^2. One species was excluded because no spatial data were available.

extinctions could be as many as 222 over the last 150 years if all CR(PE) species are indeed extinct.

When considering all threatened amphibians, the most commonly documented threats are types of habitat loss and degradation, with the top three being agriculture (77% of species impacted), timber and plant harvesting (53%), and infrastructure development (40%) (Fig. 2). Climate change effects (29%) and disease (29%) are other common threat types. Although these are important findings, they do not account for the severity and scope of these threats.

The RLI

The RLI is an indicator calculated from Red List categories to measure trends in extinction risk over time[5]. RLI values range from 1 (all species

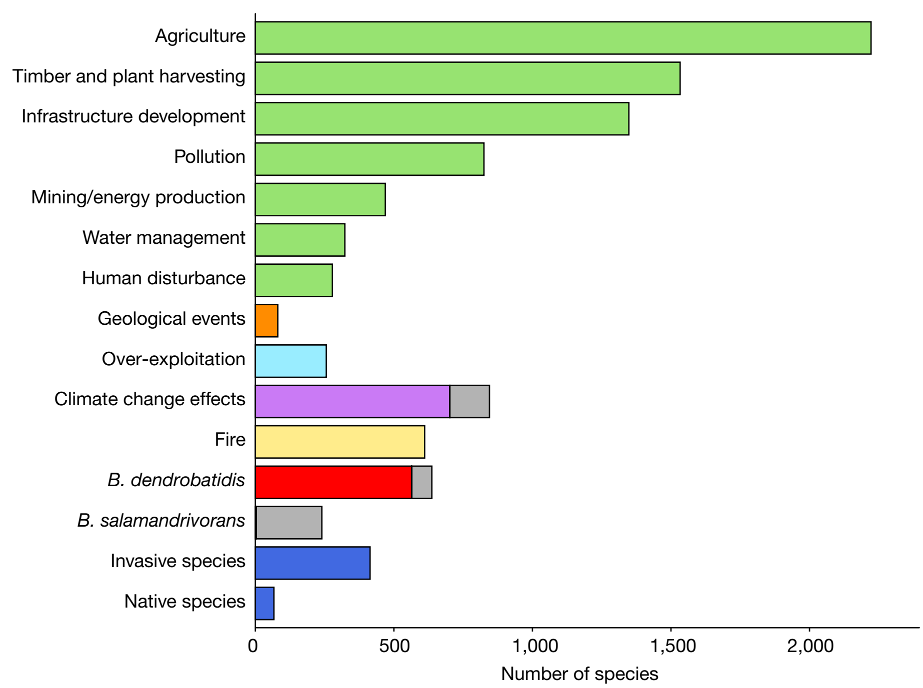

Fig. 2 | The types of threats affecting amphibian species in threatened categories. The threats to a species were coded using the threat-classification scheme and grouped for ease of comparison (see the 'Classification schemes' and 'Threats to threatened species' sections of the Methods). All threats shaded in green are causing habitat loss and degradation. The grey sections denote the number of species for which the threat timing is in the future rather than ongoing. Note that most species are experiencing multiple threats.

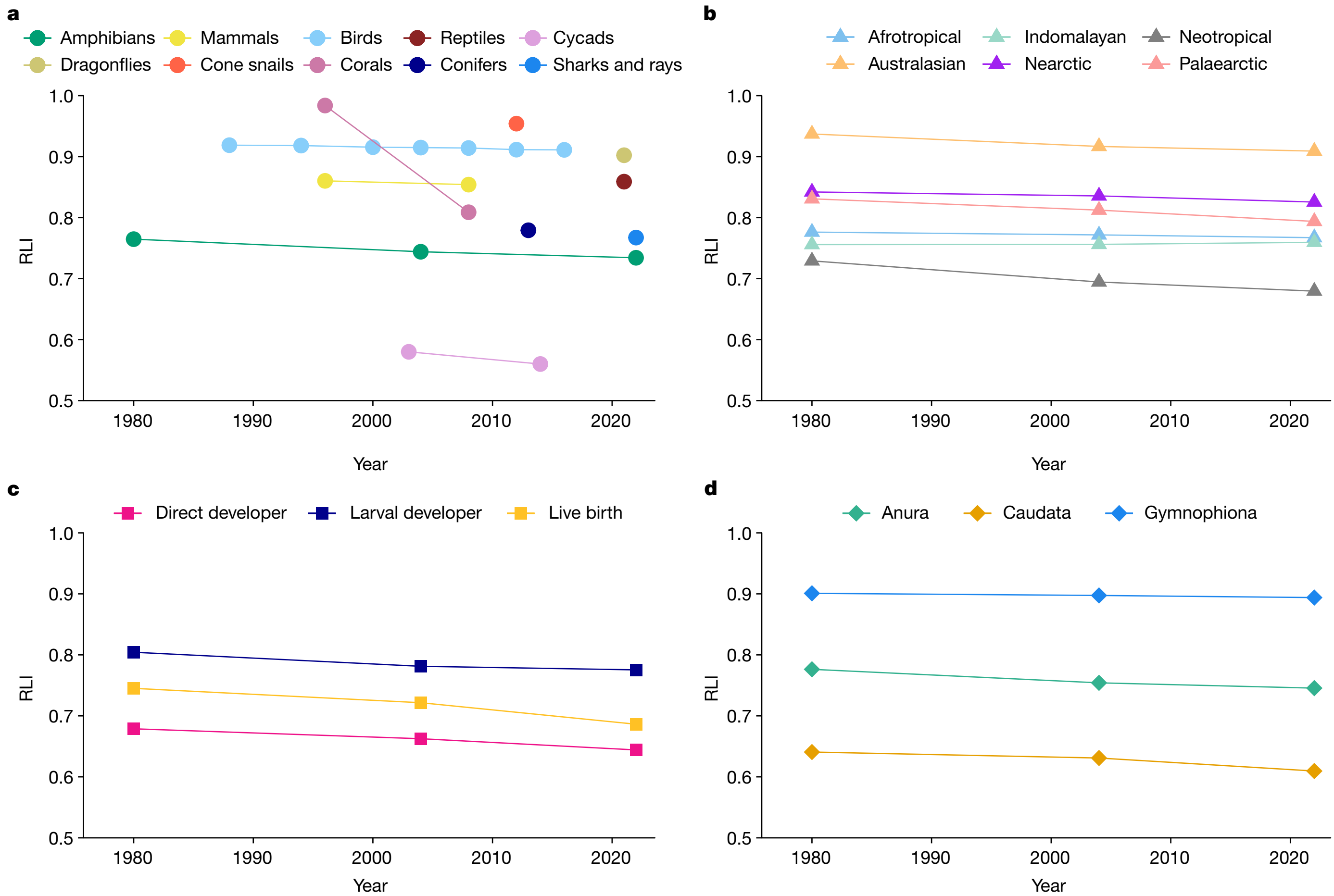

Fig. 3 | RLIs showing trends in overall extinction risk. a, The RLIs of all comprehensively assessed taxonomic groups on the IUCN Red List. **b**, The amphibian RLI disaggregated by biogeographical realm. **c**, The amphibian RLI disaggregated by breeding strategy. **d**, The amphibian RLI disaggregated by order.

are Least Concern) to 0 (all are Extinct). A change in the value is influenced only by species moving between categories due to genuine improvements or deteriorations in status, with non-genuine category changes excluded through backcasting (see the 'RLI' section of the Methods). The RLI was calculated for amphibians for 1980, 2004 and 2022 using the data collected in this study, and compared to other species groups[13] (Fig. 3a). A negative RLI trend is observed in all groups with more than one RLI datapoint, indicating that the number of species in higher extinction risk categories is increasing (Fig. 3a). Although the amphibian RLI trend between 2004 and 2022 is slightly less steep compared with the previous period, it continues to decline.

Trends in extinction risk differ across biogeographical realms (Fig. 3b and Extended Data Table 3). The Neotropics (with 48% of amphibians) has the lowest RLI value of all realms and has the greatest deterioration in status, although the gradient lessens during 2004–2022. The Neotropical trend is associated with chytridiomycosis outbreaks in the 1970s–2000s, with many of the most susceptible species affected before 2004. Australasia has the highest RLI, primarily because there are comparatively fewer threats to the large number of species on New Guinea, which is currently a chytridiomycosis-free refuge[21] with a reasonable possibility of a period of outbreak and decline in the future. The Palaearctic and Nearctic RLIs show accelerating declines during 2004–2022. In the Palaearctic, habitat loss and degradation is the leading cause followed by the emerging threat of the fungal pathogen *Batrachochytrium salamandrivorans*, whereas, in the Nearctic, climate change effects are the most common cause, followed by habitat loss and degradation. The RLI trend for the Afrotropics is declining across both periods, initially driven by habitat loss/degradation but, more recently, disease emerges as the most common cause. The Indomalayan RLI trend shows a slight improvement between 2004 and 2022, probably due to the creation and improved management of protected areas.

Among the three most common breeding strategies for amphibians, extinction risk is higher for direct developers than for larval developers and live bearers (Fig. 3c and Extended Data Table 3; see the 'Breeding strategy' section of the Methods). The RLI of all three groups declined at a similar rate between 1980 and 2004. However, during 2004–2022, it slows for larval developers and slightly accelerates for live bearers and direct developers. This result is probably due to larval developers having been especially impacted by *B. dendrobatidis* before 2004 when chytridiomycosis outbreaks were at their peak (particularly in high-elevation streams). The causes of differing extinction risks between breeding strategies merit further study.

Extinction risk also exhibits important phylogenetic patterns (Fig. 3d and Extended Data Table 3). The RLI for Caudata (salamanders and newts) is consistently the lowest, making them the most threatened. Although the RLI for Caudata declined at a lesser rate than for Anura (frogs) during 1980–2004, the rate of decline increased between 2004–2022. By contrast, the RLI for Anura declined at a much greater rate between 1980 and 2004, but at a lesser rate between 2004 and 2022, probably due to the timing of global chytridiomycosis outbreaks. A slight downward trend is shown for Gymnophiona (caecilians) with the caveat that they are very poorly studied: only 115 out of the 206 assessed are included in the RLI due to 44% being categorized as data deficient and 17% are threatened.

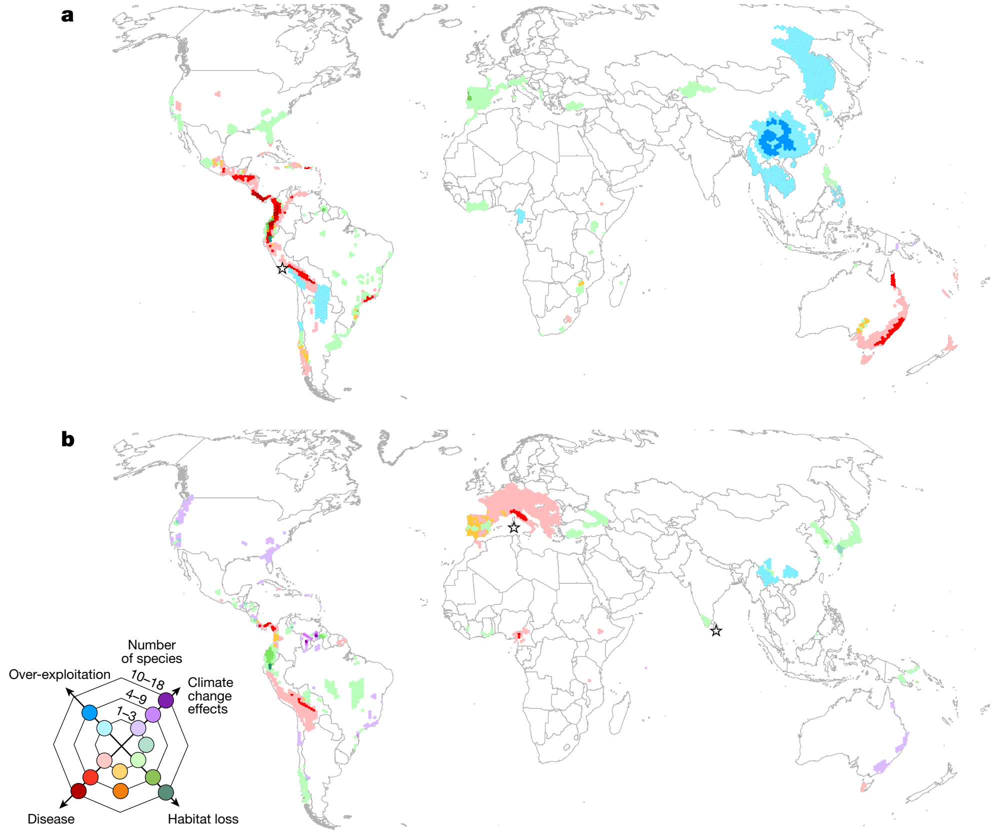

Fig. 4 | Geographical pattern of the primary drivers of deteriorating status among amphibians. a,**b**, The primary drivers of deteriorating status among amphibians during 1980–2004 (482 species; **a**) and 2004–2022 (306 species; **b**). Cell colour was determined by the primary driver impacting the most species. Where two primary drivers equally contribute to a cell, an intermediate colour is shown. The stars indicate where the primary driver is undetermined or there are numerous primary drivers. The cell area is 7,775 km^2.

Genuine changes in status

To better understand which threats are driving deteriorations in status, the subset of species that changed Red List categories over time were examined further. For each species in the subset, the threat that contributed most substantially to the deterioration in status was determined and defined as the primary driver. These are categorized into four main groups: disease, climate change effects, habitat loss/degradation and over-exploitation (Extended Data Table 2; see the 'Grouping of primary drivers' section of the Methods). Since 1980, 87% of category changes involved a change into a higher extinction risk category, with 482 of those changes occurring between 1980 and 2004 (Supplementary Table 3a) and 306 between 2004 and 2022 (Supplementary Table 3b).

The geographical pattern of primary drivers for amphibians with a deteriorating status is not uniform (Fig. 4). Disease was the primary driver for 281 species (58%) during 1980–2004, compared with 69 species (23%) during 2004–2022 (Extended Data Table 2). Disease is recorded as the dominant primary driver of status deteriorations from Costa Rica to the Andes of South America during 1980–2004 and 2004–2022, while newer hotspots of disease-related declines are appearing in central and eastern Africa (Fig. 4). *B. salamandrivorans* is an emerging threat in Europe (Fig. 4b), where status deteriorations are being driven by projected declines for some species.

There are some interesting points of difference when comparing the current distribution map of all threatened species (Fig. 1) to the distribution of species that have deteriorated in status between 2004 and 2022 (Fig. 4b). Several global hotspots for threatened amphibians such as Madagascar, Hispaniola, the Eastern Arc Mountains of Tanzania and the southern Annamite Mountains of Vietnam are notably absent from the map of species that deteriorated in status. In these regions, threats have been ongoing for decades, and many species are already considered to be highly threatened. For example, deteriorations in status due to disease and high rates of habitat loss on Hispaniola are apparent in the previous time period 1980–2004 (Fig. 4a), with a large proportion of species endemic to the island already on the brink of extinction at the time GAA1 was completed. On the contrary, other global hotspots for threatened amphibians continue to experience status deteriorations. Two of the most speciose regions of the world for amphibians—the Tropical Andes and Mesoamerica—have held considerable numbers of species that have deteriorated in status since 1980.

Species moving into the highest extinction risk categories are much more likely to have been affected by disease (Fig. 5), as chytridiomycosis results in rapid and widespread population declines for susceptible species[9,10]. Disease is the primary driver for 76% of category changes to CR and 79% of changes to CR(PE) between 1980–2004 and remains the primary driver pushing species into CR(PE) between 2004 and 2022 (89%; Fig. 5). By contrast, status deteriorations due to projected climate change effects are more frequently into categories of lower extinction risk (that is, Near Threatened or Vulnerable).

Climate change effects are the most common primary driver of status deteriorations during 2004–2022, with 119 species (39%) affected compared with 6 species (1%) during 1980–2004 (Fig. 4 and Extended Data Table 2). A notable example is the amphibians endemic to Venezuelan tepuis (table-top mountains) (Fig. 4b and Supplementary Table 1), which are particularly vulnerable to predicted habitat shifting due to climate change because vertical migration and dispersal are

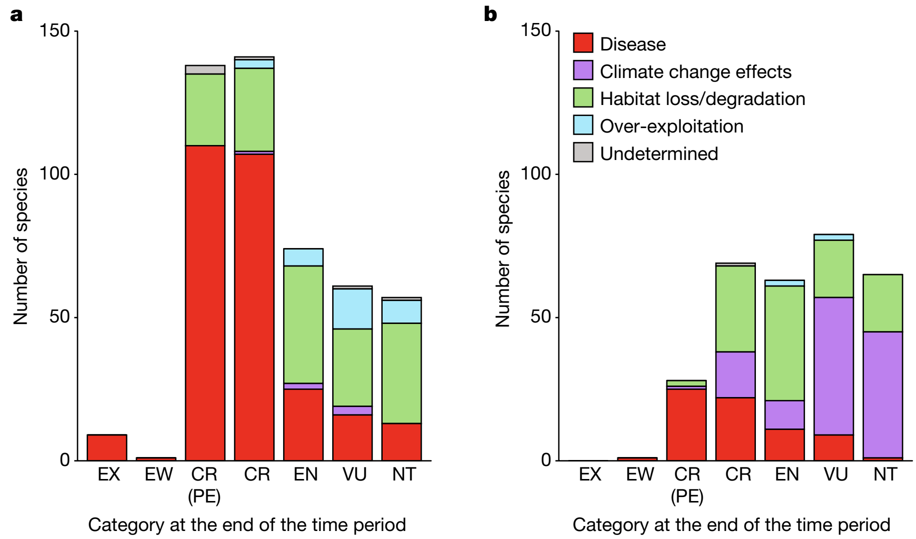

Fig. 5 | Species moved into a higher Red List category coded by the primary driver causing the change. a,**b**, The number of species moved into a higher Red List category, coded by the primary driver causing the change, during 1980–2004 (**a**) and 2004–2022 (**b**). Red List categories are ordered by highest to lowest threat level: Extinct (EX), Extinct in the Wild (EW), Critically Endangered (CR), Endangered (EN), Vulnerable (VU) and Near Threatened (NT). CR species that are likely to be extinct have the Possibly Extinct (PE) tag.

impossible. Decreased rainfall due to climate change in the Wet Tropics of Australia and Brazil's Atlantic Forest is also predicted to reduce the reproductive success of direct-developing frogs (for example, in the genera *Cophixalus* and *Brachycephalus*) owing to their dependence on high levels of soil and leaf-litter moisture to prevent egg desiccation. In eastern Australia and western United States, climate change is increasing the frequency, duration and severity of droughts and fires[22], often compounding existing threats from disease and habitat loss. For example, five US salamander species in the genus *Batrachoseps* have deteriorated in status due to the increasing effects of fires and reduced soil humidity. Given the scarcity and geographical bias of studies on the effects of climate change on amphibians[23], the true impacts are probably underestimated. As further studies are published and climate change effects continue to increase and intensify, the status of additional amphibians is expected to deteriorate.

Habitat loss and degradation remains the most prevalent primary driver of status deteriorations in many regions (156 species or 32% in 1980–2004, 112 species or 37% in 2004–2022) (Extended Data Table 2). Between 2004 and 2022, hotspots caused by ongoing or projected habitat loss are prominent in the Andes of Ecuador, central Guyana and Republic of Korea (Fig. 4b).

Although most category changes since 1980 are deteriorations (788), 120 species have shown improvements in status, moving to less-threatened Red List categories (Extended Data Fig. 1 and Supplementary Table 4a,b). Conservation actions are responsible for 63 of these improvements, 94% of which are results from effective habitat protection and improved habitat management in regions such as the Western Ghats in India, Costa Rica and Sabah in Malaysia.

Another 57 species (largely from the Neotropics and Australia) improved unaided, most of which are now persisting and, in some cases, recovering after experiencing a rapid decline associated with chytridiomycosis. It is evident that there are still no definitive conservation measures known to prevent ongoing decline from disease in wild populations, although many of these species can benefit from habitat protection. For example, some species that previously experienced declines due to disease, but are now persisting, have improved in status because their habitat has remained protected (for example, the Australian species *Litoria aurea*, *Litoria dayi*, *Litoria nannotis*, *Litoria pearsoniana*, *Litoria raniformis* and *Litoria rheocola*). Whereas other species that are persisting after *B. dendrobatidis*-associated declines may not experience an improvement in category if high rates of habitat loss and degradation are present within their distributions.

Discussion

The findings of this study confirm that the global amphibian extinction crisis has not abated. Crucially, the primary driver of status deteriorations is shifting from disease to the emerging threat of climate change. This is of particular concern because it often exacerbates other threats, such as land-use change, fire or disease[24–26]. Thus, the GAA2 results highlight the need to investigate and implement conservation actions that address the species-specific effects of climate change, particularly for species identified as imminently at risk of serious population declines.

This study also reinforces that effective habitat protection continues to be a priority for amphibian conservation, as it contributed to the greatest number of status improvements since 1980. However, more amphibians are threatened with extinction than ever before, underscoring the urgency of halting the destruction and degradation of their habitats. Critically, the legal and illegal expansion of agriculture, including animal agriculture and cash crops, is the single most important threat to amphibians worldwide (Fig. 2). The effective protection of globally important sites for amphibians, including Alliance for Zero Extinction sites and other Key Biodiversity Areas[27] (two conservation tools that draw on IUCN Red List data), can safeguard remaining habitat for threatened or geographically restricted species.

The GAA2 data also demonstrate that effective habitat protection alone is not always sufficient in addressing the threats of disease, over-exploitation or climate change effects, as many threatened amphibians already occur within protected areas. Thus, the integration of priority amphibian sites within the wider landscape, to ensure connectivity and enable dispersal, will be important in the face of global change scenarios, as has also been suggested by other studies[28,29]. Furthermore, to avoid a second global amphibian pandemic, which has the potential to trigger a new wave of status deteriorations similar to those related to *B. dendrobatidis* (Figs. 4a and 5a), preventing the spread of *B. salamandrivorans* throughout Europe and its introduction into the Americas is essential[30–32]. Monitoring populations for other new disease risks[33] and developing practical disease management tools are also recommended. Integrating ex situ measures into conservation plans can buy time[34], especially for the 798 CR species that are at the highest risk of extinction.

The large proportion of Data Deficient amphibians (909 species) continues to require further research to determine their extinction risk and conservation needs (see the 'Data Deficient species' section of the Methods). Many of these are likely to be threatened[35–37]. More broadly, increased population monitoring worldwide[38] is crucial to informing conservation actions and future reassessments. These with other recommended actions are highlighted in the IUCN SSC Amphibian Conservation Action Plan[39].

In support of the conservation actions above, policy responses to the ongoing amphibian extinction crisis, and the biodiversity crisis as a whole, need to be strengthened. Increased political will and sufficient resource commitments for the delivery of agreed global and national biodiversity conservation targets are necessary for the future survival and recovery of this amazingly diverse group of animals.

Online content

Any methods, additional references, Nature Portfolio reporting summaries, source data, extended data, supplementary information, acknowledgements, peer review information; details of author contributions and competing interests; and statements of data and code availability are available at https://doi.org/10.1038/s41586-023-06578-4.

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Methods

Data compilation

The Amphibian Red List Authority (ARLA) of the IUCN SSC Amphibian Specialist Group (ASG) coordinated the GAA2 according to the ASG's groupings of countries into regional working groups (Supplementary Table 2). Only a subset of the ASG regions was actively updating assessments at any one time.

Each regional assessment process addressed the endemic and non-endemic species in four stages: (1) pre-assessment; (2) expert consultation; (3) assessment finalizing and consistency checks; and (4) review. After the four stages were completed for all regions, the ARLA team retrospectively assigned a Red List category to all species for the years 1980 and 2004 (see the 'Backcasting Red List categories' section).

Pre-assessment. The GAA2 comprises reassessments of the 5,743 GAA1 species and the majority of species described and assessed for the first time between the two GAA projects (2004–2011). The GAA2 also contains an additional 2,286 newly described species assessed for the first time.

Regional species lists were compiled, incorporating taxonomic changes and new species descriptions collated by Amphibian Species of the World[40]. Literature reviews were conducted and any new published information was incorporated into draft assessments. In the case of reassessments, the newly available data were added to that of the previous assessment.

A particular challenge to this project is the dynamic state of amphibian taxonomy. By 2022, 191 of the GAA1 species had been synonymized, 24 were no longer considered valid species, three were considered hybrids and therefore ineligible for reassessment and four had been unintentionally assessed twice under different names.

Expert consultation. Over 1,000 subject-matter experts provided information to complete the required assessment fields (see the 'Extended acknowledgements' section in the Supplementary Information). A considerable amount of effort went into engaging with a diversity of experts across several axes (for example, gender, early versus late career researchers, geography, type of expertise) so as to reach the widest range of experts as possible and minimize reliance on any individual expert.

Future Global Amphibian Assessment initiatives would benefit from increasing the breadth of expertise engaged. Increased participation from conservation organizations and natural resource management or wildlife branches of governments should be targeted. Participants of both the first and second Global Amphibian Assessment were often members of academic institutions with expertise on herpetology, biogeography, taxonomy, and so on, as they were often the only scientists to have ever seen the species and visited known sites, and because they were typically experts in the species of the region or family of species being assessed. That said, participants without expertise in herpetology but with relevant expertise on regional threatening processes such as climate projections and wildlife trade, conservation planning, policy and implementation have the potential to improve the quality of the threat and conservation fields in the assessments.

Expert consultation of draft assessments was achieved through 31 in-person workshops, three remote workshops with over 180 online meetings, as well as phone and email correspondence (Supplementary Note 2). All workshops began with brief training in the IUCN categories and criteria, terms and definitions, and summary information from the *Guidelines for Using the IUCN Red List Categories and Criteria*[20] (IUCN Red List Guidelines). The online IUCN Red List Assessor Training Course[41] was made available ahead of workshops as an optional form of preparation, along with the *IUCN Red List Categories and Criteria*[42].

The expert consultation process was led by IUCN Red List trained facilitators and followed the IUCN Rules of Procedure[43]: (1) expert validation of the data in the assessments drafted during the pre-assessment stage. (i) In the early years of the GAA2 initiative, draft assessments were sent to experts for comment ahead of the data validation workshops. However, providing comments and data ahead of workshops quickly became infeasible due to the sheer number of species to be assessed. Thus, the preferred approach was for all data (both previous and new data) to be presented in sequential order to experts during workshops. (2) Contribution of missing data and/or revision of data with suitable justification. (i) In cases in which expert knowledge and/or unpublished data updated the information in the draft assessments, these were discussed and added during the workshop. (ii) Where possible, data quality was recorded using standardized data qualifiers (for example, observed, estimated, inferred, suspected) depending on the nature of evidence. Where no direct observational data were available, data fields (for example, population size and severity of threats) were derived through expert estimation or inference, according to 'Chapter 3: Data Quality' of the IUCN Red List Guidelines. Contributing experts were given an opportunity to comment or to revise any initial estimates, once they had a chance to discuss differences and to see the opinions of others. (3) Group discussion and application of the IUCN Red List Categories and Criteria to the data. (i) Uncertainty in the data and differences in risk tolerance between contributing experts were documented as a range of values in accordance with section 3.2.5 of the IUCN Red List Guidelines. When this resulted in a range of possible Red List categories being met (for example, Endangered–Critically Endangered), the range of categories was captured in the assessment rationale and a single category was chosen with clear justification for the decision, including whether an evidentiary or precautionary attitude was adopted. In cases in which the uncertainty was deemed to be too great, the category of Data Deficient was applied in compliance with section 10.3 of the IUCN Red List Guidelines. (ii) Of note are the differences in contribution between the workshop participants and workshop facilitators. The former brought expertise on the species and data relevant to the assessment, whereas the latter were experts in the IUCN categories and criteria. Thus, assessments were the product of both types of contributions.

We acknowledge that more formal elicitation methods, such as structured expert elicitation, can identify and reduce potential sources of bias and error among experts when contributing data and making judgements. This structured process could prove to be valuable for future IUCN Red List assessment processes, particularly for high-profile or contentious taxa, although it may be impractical for less-contentious taxa due to the amount of time required[44].

Assessment finalizing. The supporting data and Red List categories were finalized by an ARLA team member who also performed checks to ensure that the IUCN categories and criteria were applied in a consistent manner to the species within a particular region, but also between ASG regions. An example of an inconsistent result is when different Red List categories were determined for two or more species with very similar data. Consistency was also sought for species with similar traits or co-occurring species. If inconsistency was detected, assessments were revisited with data contributors to reconcile any discrepancies.

Review. An independent reviewer ensured biological accuracy and correct and consistent application of the Red List criteria. This process involved 15 independent reviewers between 2012 and 2022 (see the 'Extended acknowledgements' section in the Supplementary Information). The IUCN Red List Unit also reviewed assessments for appropriate application of the criteria.

Data collected

Species assessments are required to meet the minimum documentation standards of the IUCN Red List as outlined in the Supporting Information Guidelines[45]. The supporting information includes information on distribution, population, habitat preferences, ecology, use and trade, threats, conservation measures as well as the IUCN Red List category and criteria. Each assessment also includes a bibliography and the names of people involved in the process. This section describes the supporting data collected for each species.

Systematics. Higher taxonomy and scientific name, taxonomic authority, major synonyms, common names and taxonomic notes (if pertinent) were collected.

Occasionally, data from experts support an alternative taxonomic arrangement from that of the Amphibian Species of the World[40], which was accepted only in well-justified circumstances. Departures from Amphibian Species of the World are documented in the 'Taxonomic Notes' field of an assessment.

Summary information. Narrative texts about geographical range, population, habitat and ecology (including breeding and non-breeding habitats, as well as breeding strategy), threats, and conservation and research measures are required.

Breeding strategy. The breeding strategy of each amphibian was recorded in the IUCN Species Information Service on the basis of whether they (1) lay eggs; (2) give birth to live young; (3) exhibit parthenogenesis; (4) have a free-living larval stage; and/or (5) require water for breeding. When appropriate, the breeding strategy of a species was inferred from one or more congeners. Species were categorized as either larval developers, direct-developers, live-birth or unknown for the purpose of this study, as follows: larval developers (5,320 species): species coded as laying eggs and having a free-living larval stage. Direct developers (2,452 species): species coded as laying eggs but do not have a free-living larval stage. Live birth (61 species): species coded as giving birth to live young (viviparity) regardless of whether they have a free-living larval stage. Unknown (178 species): species coded as unknown for one or more questions, which prevented their breeding strategy from being categorized.

Distribution map. A map representing the currently known distribution of each species was generated according to the IUCN Mapping Standards[46]. The limits of a species' distribution were mapped using known occurrences of the taxon, and knowledge of habitat preferences, elevation limits and so on. Standard data attributes on presence, origin and seasonality were recorded for each range polygon. There are 53 species in the GAA2 without distribution maps as the taxon is known only from one or more specimens with no or extremely uncertain locality information.

Additional distribution data. Occurrences in biogeographic realms[47], biodiversity hotspots[48], countries and states or provinces (where required) were coded.

Classification schemes. To allow for comparative analyses and to ensure uniformity across species, a series of classification schemes[49] was used for habitats, threats, conservation actions, research needed, and use and trade.

Red List category and criteria. The IUCN Red List criteria were applied to the supporting data and the appropriate Red List category was determined, supported by a rationale[42]. A statement of the reason(s) for change in category from the previous assessment was documented for reassessed species. The date of assessment and the names of the facilitators, compilers and contributors were recorded.

Backcasting Red List categories. Only genuine changes in Red List category should be considered when comparing extinction risk in amphibians over time. A genuine change is either a real improvement or deterioration in the status of a species, driven by changes in the threat(s). For example, the protection of a species' habitat that halted the primary threat of deforestation could result in a genuine status improvement. On the other hand, a genuine status deterioration could be due to population declines associated with the introduction of a disease, the start of human activities causing ongoing habitat loss and degradation or the projected effects of climate change.

The majority of category changes from GAA1 to GAA2 were for non-genuine reasons. Generally, these were the result of the new information, such as distributional changes or clarity on threatening processes. For example, if a species was previously considered to be a narrow range endemic but was subsequently found to be much more widespread, the resulting change to a lower extinction risk category would be considered to be non-genuine. Other non-genuine reasons for category changes included changes in the application of the criteria or incorrect data used in the previous assessment(s).

A previous study[7] relied on the knowledge available at that time to backcast their 2004 assessments to 1980. This year corresponded approximately to the timeframe of severe population declines, as they were understood at the time. The GAA1 backcasted dataset provides a historical perspective taken into consideration in the GAA2 backcasting.

In early 2022, the ARLA team backcasted the GAA2 categories to 1980 and 2004 according to a method outlined previously[5]. This method uses the information in the Red List assessments in combination with additional knowledge on threatening processes, habitat decline trends and conservation actions (and in some cases further expert consultation) to determine whether a genuine change in a species' Red List category is likely to have occurred between 1980–2004 and 2004–2022. In the absence of notable evidence suggesting a genuine change, the GAA2 Red List category was assumed to be the same for previous time periods. Data Deficient species were automatically backcasted as data deficient in 1980 and 2004. Supplementary Table 3a,b contains the list of species that have deteriorated in status along with their backcasted categories, and Supplementary Table 4a,b contains the list of species that have improved in status.

Primary drivers. During the backcasting process, for species considered to have undergone a genuine category change since 1980, the relative importance of documented threats for each species was estimated. The most notable perceived threat was assigned as the 'primary driver' and selected from the following list: agriculture, mining/energy production, infrastructure development, human disturbance, timber and plant harvesting, anthropogenic fire, water management, native species, introduced species, pollution, geological events, disease, overexploitation, climate change effects and undetermined.

Species that deteriorated in status were assigned the primary driver that contributed to the category change. For species that improved in status, the primary driver that was previously causing the deterioration but has since been mitigated were assigned. Improvements that were the result of conservation action were documented through an additional data field (Supplementary Tables 3a,b and 4a,b).

Data limitations

Regional variation. IUCN Red List assessments are considered to be out of date 10 years after the date of assessment. Thus, all species included in the GAA2 have been assessed within the past ten years and are considered current. However, for regions that were assessed earlier in the GAA2, the data are comparatively less current than for the regions completed during the latter stages of the project.

For example, towards the end of the GAA2, the severity, scope and timing of the effects of climate change were at the forefront of discussions but were not as well addressed for earlier regions. Thus, the species- and habitat-specific effects of climate change are probably underestimated for regions that were assessed earlier in the GAA2.

Data scarcity was a common issue for regions with few herpetologists and for species occurring in areas that are difficult to access. As such, assessments in data-poor regions, such as Melanesia and sub-Saharan Africa, generally contain substantially less detail compared with data-rich regions such as North America, Australia and Europe, where species are often relatively well studied. This is also true for population data, where there has been little (if any) population monitoring, and threat-determining processes with scarce published literature on climate change, rates of habitat loss or exploitation.

The rate of new species descriptions also varies regionally, with the amphibian fauna in many parts of the world still very poorly known. Thus, the currently known amphibian richness and diversity is substantially underestimated in those places.

Not evaluated species. The GAA2 aimed to assess the extinction risk of all taxonomically valid amphibian species. However, as the annual rate of new species descriptions remains high, inevitably some newly described species are not included in the GAA2. After a region had been completed during the GAA2, all subsequent new species descriptions for that region were reserved for the GAA3. On occasion, a few species were assessed after the Red List update for a region was no longer active—typically when a species was known to be facing serious threats or there were taxonomic implications for regions that were actively being updated. As of December 2022, the number of new species waiting to be assessed in the GAA3 was approaching 400 and is steadily increasing as new species descriptions are published weekly.

Data Deficient species. In the GAA2, 909 species were categorized as data deficient owing to insufficient data. At a minimum, Data Deficient species are expected to be threatened at a similar proportion as the global average of threatened species (40.7%). Owing to these data gaps, we expect the number of genuine changes to also be underestimated. This may be the case for Data Deficient species that have not been surveyed for decades and for which there is no information to confirm whether population declines have taken place.

Analytical methods

Percentage of threatened species. Species in the Critically Endangered (CR), Endangered (EN) and Vulnerable (VU) categories are referred to as threatened species.

When determining the percentage of threatened species in this study, a best estimate was calculated excluding the number of Data Deficient (DD) and Extinct (EX) species from the total. However, Extinct in the Wild (EW) species were included because there remains the possibility that they can be reintroduced to the wild. To capture the uncertainty within this estimate, a lower estimate was calculated by assuming that all Data Deficient species are not threatened, and an upper estimate is calculated by assuming that all Data Deficient species are threatened:

$$\text{Lower estimate} = (\text{EW} + \text{CR} + \text{EN} + \text{VU})/(\text{total species} - \text{EX})$$

$$\text{Best estimate} = (\text{EW} + \text{CR} + \text{EN} + \text{VU})/(\text{total species} - \text{EX} - \text{DD})$$

$$\text{Upper estimate} = (\text{EW} + \text{CR} + \text{EN} + \text{VU} + \text{DD})/(\text{total species} - \text{EX})$$

For further details and discussion of these methods, see the IUCN Red List Resources Summary Statistics documentation[50].

Threats to threatened species. The GAA2 coded threats affecting amphibians using the threat-classification scheme (see the 'Classification schemes' section). When relevant, more than one threat was coded per species. The timing of the threat (past, ongoing, future), and the resulting stresses to the species, were also indicated.

In Fig. 2, the hierarchy within the threat-classification scheme was used to group similar threats and allow for comparison, although some, such as *B. dendrobatidis*, were separated to highlight their significance. Only ongoing and future major threats to threatened species are included. To highlight the emerging nature of *B. dendrobatidis*, *B. salamandrivorans* and climate change effects, the number of threatened species for which these factors are only a future threat are indicated by hatching on the bars.

Threat groupings were as follows:

- Agriculture: all codes under 2 Agriculture & aquaculture.
- Timber and plant harvesting: all codes under 5.2 Gathering terrestrial plants and 5.3 Logging and wood harvesting.
- Infrastructure development: all codes under 1 Residential & commercial development and 4 Transportation & service corridors.
- Pollution: all codes under 9 Pollution.
- Mining/energy production: all codes under 3 Energy production & mining.
- Water management: all codes under 7.2 Dams & water management.
- Human disturbance: all codes under 6 Human intrusions & disturbance.
- Geological events: all codes under 10 Geological events.
- Over-exploitation: all codes under 5.1 Hunting & collecting terrestrial animals and 5.4 Fishing & harvesting aquatic resources.
- Climate change: all codes under 11 Climate change & severe weather.
- Fire: all codes under 7.1 Fire & fire suppression.
- *B. dendrobatidis*: under the codes 8.1.2 Invasive non-native/alien species/diseases—named species and 8.4.2 Problematic species/diseases of unknown origin—named species, the name of invasive/problematic species must be recorded. Only records for which *B. dendrobatidis* was listed were included.
- *B. salamandrivorans*: under the codes 8.1.2 Invasive non-native/alien species/diseases—named species and 8.4.2 Problematic species/diseases of unknown origin—named species, the name of invasive/problematic species must be recorded. Only records for which *B. salamandrivorans* was listed were included.
- Invasive species: all codes under 8.1 Invasive non-native/alien species/diseases, 8.3 Introduced genetic material, 8.4 Problematic species/diseases of unknown origin, 8.5 Viral/prion-induced diseases and 8.6 Diseases of unknown cause, except when the invasive/problematic species is identified as *B. dendrobatidis* or *B. salamandrivorans*.
- Native species: all codes under 8.2 Problematic native species/diseases.

RLI. Determining trends in the extinction risk of amphibians requires that only genuine changes in the Red List category between assessments be included in the RLI. Thus, the backcasted 1980 and 2004 categories assigned in the GAA2 (Extended Data Table 1; see the 'Backcasting red list categories' section) are used to calculate the RLI for amphibians.

The RLI is calculated according to the methods outlined previously[5] and detailed online[51]. The value of the RLI at each datapoint is an indication of the average extinction risk of all species at that point in time and can range from 0 (all species are Extinct) to 1 (all species are Least Concern). The gradient (slope) of the line is a measure of the rate of change in Red List categories. Thus, a steep negative gradient would indicate that a considerable proportion of species moved from a less threatened to a more threatened Red List category. By contrast, a positive gradient is indicative of an overall improvement.

Note that CR(PE) and EX species are weighted the same when calculating the RLI. Thus, a change in category from CR(PE) to EX from one time period to the next is not considered to be a deterioration in status; however, a change from CR to CR(PE) is treated as such. Data Deficient species are not included in the RLI as their extinction risk is still unknown.

The RLIs for other comprehensively assessed taxonomic groups are included in Fig. 2a to allow for a direct comparison with amphibians. The relatively small number of amphibians (264) occurring across more than one biogeographical realm were included in the disaggregated RLI calculations of each realm of occurrence (Fig. 3b). This is considered to be the best approach for representing the overall extinction risk of a given realm.

The decline in the amphibian RLI could initially be interpreted as minimal. However, to put this trend into perspective, 482 amphibians moved into a higher extinction risk category between 2004 and 2022 and 306 between 1980 and 2004 (Extended Data Table 2).

Grouping of primary drivers. For species that changed categories between assessment periods, a primary driver responsible for the change was allocated (see the 'Primary drivers' section; Supplementary Table 3a,b). Many of these primary drivers cause habitat loss and degradation. For the purpose of this study, the drivers were further grouped as follows:

- Habitat loss/degradation: agriculture, mining/energy production, infrastructure development, human disturbance, timber and plant harvesting, anthropogenic fire, water management, native species, pollution, geological events.
- Disease: chytridiomycosis only.
- Over-exploitation: over-exploitation only.
- Climate change effects: climate change effects only.
- Undetermined: includes a small number of species for which there is insufficient information regarding what is/are the driver(s) of the change in category.
- Numerous: includes a small number of species (5) that have more than one driver that are considered to be contributing equally to the change in category.

Invasive species are documented as a threat to 415 threatened species (Fig. 2). However, except for the species that are probably affected by the amphibian chytrid fungus, *B. dendrobatidis*, no amphibians in this study experienced a deterioration in status due to invasive non-native species. A small number of category changes were driven by the threats native species, geological events and anthropogenic fire, which cause habitat degradation and were therefore grouped under habitat loss/degradation.

Over-exploitation was the primary driver for 31 status deteriorations during 1980–2004 compared with only 4 during 2004–2022 (Extended Data Table 2). Deteriorations in status due to over-exploitation remain concentrated in Indomalaya (Extended Data Table 3), particularly in eastern and southeastern Asia (Fig. 4). However, population declines due to over-exploitation are typically based on expert opinion because very little data exist on utilization rates of amphibians. As a result, it was often difficult to accurately determine when and to what degree a species deteriorated in status.

Reporting summary

Further information on research design is available in the Nature Portfolio Reporting Summary linked to this article.

Data availability

The spatial and raw tabular data analysed in this study are available online (https://www.iucnredlist.org/resources/data-repository). The GAA2 IUCN Red List assessments, including range maps, for all 8,011 species will be available for download on The IUCN Red List of Threatened Species website (https://iucnredlist.org) after its December 2023 update (version 2023–2). In rare cases, a species may be threatened because of over-collection and sensitive distribution information is not publicly available. Source data are provided with this paper.

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Acknowledgements We thank each of the contributors named in the Supplementary Information and D. Church, W. Sechrest, P. Ghosh, J. P. Rodriguez, K. Mileham and R. Akcakaya, without whom the GAA2 would have not been possible. The views expressed here do not necessarily reflect those of IUCN's staff, members or commissions. The designation of geographical entities in this paper, and the presentation of the material, do not imply the expression of any opinion whatsoever on the part of IUCN concerning the legal status of any country, territory or area, or of its authorities, or concerning the delimitation of its frontiers or boundaries. The majority of funds were provided by Re:wild, Synchronicity Earth, Kering and the Environment Agency—Abu Dhabi Framework Grant to the IUCN Species Survival Commission (S.N.S., J.A.L., P.L. and B.L.). Grants for specific components of the GAA2 are listed as follows. Alashan SEE Foundation grant The IUCN Red List Workshop for Chinese Amphibian Species (to J.A.L. and L.H.). Detroit Zoological Society grant Catalyzing Amphibian Conservation in Honduras (to J.A.L., K.N., L.H. and P.L.). Detroit Zoological Society grant Support to the IUCN SSC Amphibian Red List Authority for the Updates of Madagascar and the Tropical Americas (to J.A.L. and A. Angulo). Dilmah Conservation grant Updating the IUCN Red List Assessments for the Amphibians of Sri Lanka (to J.A.L., K.N., L.H. and P.L.). Honolulu Zoo grant Support to Amphibian Conservation in Southeast Asia (to J.A.L. and A. Angulo). IUCN Red List Committee allocation of funds raised in 2015, 2016, 2017, 2018, 2019 and 2020 through the Integrated Biodiversity Assessment Tool (IBAT) to the IUCN SSC Amphibian Specialist Group Red List Authority (to J.A.L., S.N.S., P.L., B.L., K.N. and L.H.). Kering grant Critical Biodiversity Information for Decision-Making (to J.A.L., P.L., K.N. and L.H.). Museo delle Scienze di Trento to the IUCN SSC Amphibian Specialist Group Red List Authority (to J.A.L. and A. Angulo). NatureServe grant Andean Species-level Indicators (to J.A.L., K.N. and L.H.). Rainforest Trust grant Identifying Priority Sites for the Most Threatened Amphibian Species (to J.A.L., K.N., L.H and S.N.S.). Yayasan Belantara grant support for the Indonesian Amphibian Red List Assessment Workshop (to M.D.K. and A.H.). In addition to the many institutions that hosted workshops and provided the time of their staff to participate in the GAA2, we recognize the contributions of the following organizations: the American Museum of Natural History's Amphibian Species of the World; Re:wild; the IUCN Biodiversity Assessment Unit; the Amphibian Survival Alliance; the IUCN SSC Chair's Office; the Red List Technical Working Group; Amphibian Ark; NatureServe; Synchronicity Earth; and iNaturalist. Serving as the gatekeeper to the Red List, the members of the IUCN Red List Unit provided technical training and support, maintenance of the online Species Information Service database, assessment checks and publication of assessments on the Red List website. We recognize in particular the contributions of A. Joolia, A. M. Richardt, C. Pollock, C. Hilton-Taylor, J. Scott and J. Window. The GAA2 was an extensive collaboration of over 1,000 individuals. We acknowledge their contributions and have listed their contributions individually in the 'Extended acknowledgements' section of the Supplementary Information.

Author contributions Conceptualization: J.A.L., J.C., K.N., L.H., B.L., P.L. and S.N.S. Methodology: J.A.L., J.C., K.N., L.H., C.H.-T., B.L., P.L. and S.N.S. Validation: J.A.L., J.C., K.N., L.H., C.H.-T., B.L., P.L. and S.N.S. Formal analysis: J.C., K.N. and C.H.-T. Investigation: J.A.L., J.C., K.N., L.H., A.A.K., A. Angulo, A. Aowphol, A.B., A.C., A.C.D., A.F., A.F.G., A.H., A.J., A.M.S., A.O.M., A.d.S., A.S.-B., A.T., B.G., B.S., B.T., C.A., C.C.M.R., C.F.C.F., C.H.-T., C.J.H., C.R.V.A., C. Señaris, C.S.R., C. Strüssmann, D.F.C.-H., D.H.O., D.J.G., D.J.S., D.L.W., E.N., E.N.-M., E.S.H.Q., F.A., F. Bolaños, F. Brusquetti, F.E.C., F.G., F.K., F.S.Á., F.X., G.C., G.F.M.-R., G.G.-D., G.P.-O., H.M.O.-A., I.D., I.F.M., I.R.D., J.C.-I., J.-H.Y., J.J., J.J.L.R., J.M., J.N.U.-C., J.T.W., K.O., K.O.C., K.V., K.V.G., L.C.-M., L.C.W., L.F.T., L.M.D., M.A.P., M.D.K., M.E.A., M.F., M.F.A., M.F.N., M.H.Y.-M., M.L., M. Matsui, M. Meegaskumbura, M.M.H.K., M.-O.R., M.R., M.D.S., M.V., N.G., N.G.G.K., N.L.G., P.A.B., P.J.R.K., P.W., P.Y.I., R.A.B., R.I., R.J.A., R.L.J., R.v.M., S.B.H., S.D., S.D.B., S.G., S.J.I., S.J.R., S.J.R.-H., S.L.A., S.P., S.P.L., S.R.G., S.V.F., S.W., T.H.C., T.O.-N., T.P.C., T.P.F.A.-J., T.Q.N., T.R.D.C., T.S., T.W.P., U.K. and Z.Y. Data curation: JAL, JC, KN, LH, C.H.-T., EN, LCW, NG, T.P.F.A.-J. Writing—original draft: J.A.L., J.C., K.N., L.H., B.L., P.L. and S.N.S. Writing—review and editing: J.A.L., J.C., K.N., L.H., A.A.K., A. Angulo, A. Aowphol, A.B., A.C., A.C.D., A.F., A.F.G., A.H., A.J., A.M.S., A.O.M., A.d.S., A.S.-B., A.T., B.G., B.S., B.T., C.A., C.C.M.R., C.F.C.F., C.H.-T., C.J.H., C.R.V.A., C. Señaris, C.S.R., C. Strüssmann, D.F.C.-H., D.H.O., D.J.G., D.J.S., D.L.W., E.N., E.N.-M., E.S.H.Q., F.A., F. Bolaños, F. Brusquetti, F.E.C., F.G., F.K., F.S.Á., F.X., G.C., G.F.M.-R., G.G.-D., G.P.-O., H.M.O.-A., I.D., I.F.M., I.R.D., J.C.-I., J.-H.Y., J.J., J.J.L.R., J.M., J.N.U.-C., J.T.W., K.O., K.O.C., K.V., K.V.G., L.C.-M., L.C.W., L.F.T., L.M.D., M.A.P., M.D.K., M.E.A., M.F., M.F.A., M.F.N., M.H.Y.-M., M.L., M. Matsui, M. Meegaskumbura, M.M.H.K., M.-O.R., M.R., M.D.S., M.V., N.G., N.G.G.K., N.L.G., P.A.B., P.J.R.K., P.W., P.Y.I., R.A.B., R.I., R.J.A., R.L.J., R.v.M., S.B.H., S.D., S.D.B., S.G., S.J.I., S.J.R., S.J.R.-H., S.L.A., S.P., S.P.L., S.R.G., S.V.F., S.W., T.H.C., T.O.-N., T.P.C., T.P.F.A.-J., T.Q.N., T.R.D.C., T.S., T.W.P., U.K., Z.Y., B.L., P.L. and S.N.S. Visualization: J.C. and K.N. Supervision: J.A.L., J.C., C.H.-T., B.L., P.L. and

S.N.S. Project administration: J.A.L., J.C., K.N., L.H., A. Angulo, A.C., A.C.D., A.M.S., A.d.S., A.T., C.A., C.C.M.R., C.F.C.F., C.R.V.A., C. Señaris, D.F.C.-H., D.H.O., E.N.-M., F.A., F.E.C., F.G., F.X., G.C., G.P.-O., I.F.M., J.C.-I., J.J., J.J.L.R., J.M., J.N.U.-C., J.T.W., K.O., K.O.C., K.V., K.V.G., M.D.K., M.L., M. Matsui, M. Meegaskumbura, M.-O.R., M.D.S., M.V., N.L.G., R.I., S.B.H., S.J.I., S.J.R., S.P.L., S.W., T.P.C., T.W.P. and U.K. Funding acquisition: J.A.L., K.N., L.H., A.C.D., F.A., J.J.L.R., J.M., M.D.K., B.L., P.L. and S.N.S.

Competing interests The authors declare no competing interests.

Additional information

Supplementary information The online version contains supplementary material available at https://doi.org/10.1038/s41586-023-06578-4.

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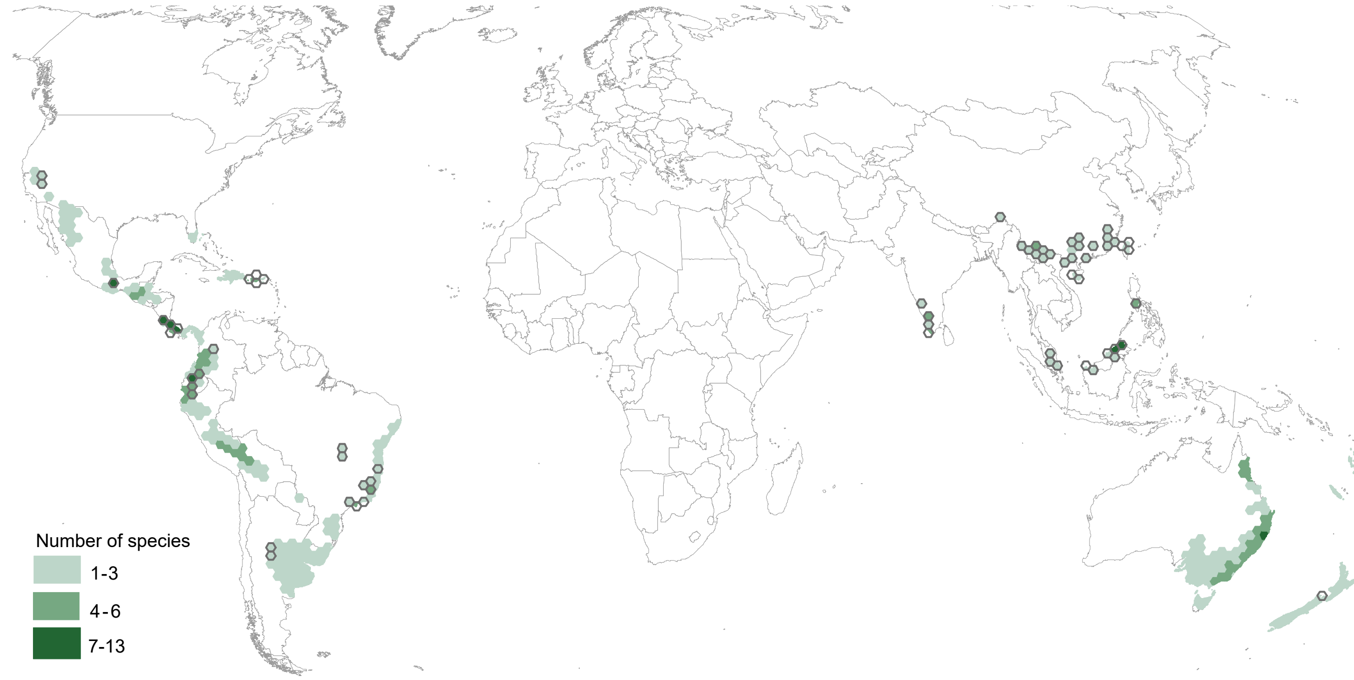
Peer review information *Nature* thanks Ross Alford and Joaquin Hortal and the other, anonymous, reviewer(s) for their contribution to the peer review of this work. Peer reviewer reports are available.



Extended Data Fig. 1 | Geographical pattern of 120 amphibians that improved in status between 1980–2022. Outlined hexagons indicate at least one species improved due to conservation.

Extended Data Table 1 | Number of species in each Red List category for 1980, 2004, and 2022

Red List Category	1980	2004	2022
EX	23	33	37
EW	0	1	2
CR(PEW)	0	1	1
CR(PE)	24	162	185
CR	564	604	612
EN	1,293	1,235	1,264
VU	800	786	811
NT	384	413	451
LC	4,014	3,868	3,739
DD	909	909	909
Percentage of Species Threatened			
Lower estimate	33.6	35.0	36.1
Best estimate	37.9	39.4	40.7
Upper estimate	44.9	46.3	47.5

The 1980 and 2004 categories were determined by applying the backcasting methods outlined in Butchart et al.[5]. The 2022 Red List categories are the results of the GAA2 study and the most recent assessment for each species. The Critically Endangered (CR) category has an additional option to tag a species as "Possibly Extinct (PE)" or "Possibly Extinct in the Wild (PEW)". The disaggregation of CR species has been provided in this table to emphasize the large number of amphibians that are categorised as CR(PE). Following the methods outlined in Section 4.1, the best, lower, and upper estimate of the percentage of threatened or extinct species is calculated for each point in time. There has been a steady increase in the percentage of threatened amphibians from 37.9% (1980) to 39.4% (2004) to 40.7% (2022). It should be noted that the two time periods (1980–2004 and 2004–2022) are not equal; the first one being 24 years and the second only 18. From 1980 to 2004, an additional 118 species were categorised as threatened. An additional 90 species are threatened as of 2022. From 1980 to 2004, the total number of species listed as VU and EN decreased, while the number listed as CR considerably increased from 588 to 766. In 1980, 24 species were considered CR(PE), but by 2004 the number of CR(PE) species rose to 162. The number of species declared EX also increased from 23 in 1980, to 33 in 2004. In contrast, from 2004 to 2022, the number of species in each of the threatened categories increased by a similar amount; the number of CR(PE) species increased by 23; and the number of EX species increased by four, which is substantially less than the previous time period, but still of significant conservation concern.

Extended Data Table 2 | Species with status deteriorations in each time period (1980–2004 and 2004–2022)

Grouped driver	Primary driver	1980–2004	2004–2022
Disease		**281**	**69**
Habitat loss/ degradation		**156**	**112**
	Agriculture	93	57
	Mining/energy production	22	27
	Infrastructure development	19	11
	Timber and plant harvesting	9	1
	Water management	8	4
	Human disturbance	2	2
	Anthropogenic fire	1	5
	Pollution	1	1
	Geological events	1	1
	Native species	0	3
Over-exploitation		**31**	**4**
Climate change effects		**6**	**119**
Undetermined		**6**	**1**
Numerous		**2**	**1**
Total		**482**	**306**

Species are categorised by the primary driver of the status deterioration. Primary drivers are grouped in the first column and separated in the second.

Extended Data Table 3 | Number of species with status deteriorations in each time period (1980–2004 and 2004–2022) disaggregated by the data groupings used to calculate the Red List Indices and primary drivers of status deteriorations

Data grouping	Primary driver					
	Time period	Disease	Habitat loss/ degradation	Over-exploitation	Climate change effects	Numerous
Afrotropics	1980–2004	3	12	1	0	0
	2004–2022	11	3	0	4	0
Australasia/ Oceania	1980–2004	25	4	0	4	0
	2004–2022	2	8	0	11	0
Indomalaya	1980–2004	0	3	9	0	0
	2004–2022	0	5	1	0	1
Nearctic	1980–2004	4	10	0	1	0
	2004–2022	0	5	0	12	0
Neotropics	1980–2004	250	114	4	1	2
	2004–2022	45	77	0	91	0
Palaearctic	1980–2004	0	26	12	0	0
	2004–2022	11	16	2	1	0
Larval developer	1980–2004	203	107	31	1	2
	2004–2022	51	65	4	42	1
Direct developer	1980–2004	76	45	0	5	0
	2004–2022	15	47	0	73	0
Live birth	1980–2004	1	3	0	0	0
	2004–2022	3	0	0	2	0
Anura	1980–2004	272	139	23	5	2
	2004–2022	57	89	1	103	1
Caudata	1980–2004	9	15	8	1	0
	2004–2022	12	22	3	16	0
Gymnophiona	1980–2004	0	2	0	0	0
	2004–2022	0	1	0	0	0

In the Neotropics, disease stands out as by far the most common driver of status deteriorations between 1980–2004 (250 species), but this driver diminished between 2004–2022 (45 species). Climate change effects were only implicated for one species in the Neotropics between 1980–2004 but increased substantially to 91 species between 2004–2022. A similar trend is shown in the Nearctic and Australasia/Oceania. Interestingly, the Afrotropical region shows the reverse trend for disease, with the number of species deteriorating in status increasing from three in the first time period to 11 in the second, due to recent *Bd* outbreaks emerging in central and eastern Africa. In the Palaearctic, the increasing impact of disease is also noticeable, and can be attributed to the recent introduction of *Bsal* and the impact its predicted spread will have on many salamanders. For Anura, the impact of disease has greatly diminished with time, and climate change effects have more recently emerged as the most common primary driver, although habitat loss/degradation is still prominent. With the emergence of *Bsal*, disease has remained an overall concern for Caudata, although climate change effects are now also considered the most common primary driver. The trend of diminishing impacts due to disease in the first period, and the emergence of climate change effects in the second period seems to be similar for both larval and direct developers.

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Last updated by author(s): 30 June 2023

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The spatial and raw tabular data analysed in this study are available at https://doi.org/10.5061/dryad.xgxd254n5.
The GAA2 IUCN Red List assessments, including range maps, for all 8,011 species will also be available for download on The IUCN Red List of Threatened SpeciesTM website (https://iucnredlist.org) following its September 2023 update (version 2023–1).

In rare cases, a species may be threatened because of over-collection and sensitive distribution information is not publicly available.
Source data are provided with this paper.

Research involving human participants, their data, or biological material

Policy information about studies with human participants or human data. See also policy information about sex, gender (identity/presentation), and sexual orientation and race, ethnicity and racism.

Reporting on sex and gender	N/A
Reporting on race, ethnicity, or other socially relevant groupings	N/A
Population characteristics	N/A
Recruitment	N/A
Ethics oversight	N/A

Note that full information on the approval of the study protocol must also be provided in the manuscript.

Field-specific reporting

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Ecological, evolutionary & environmental sciences study design

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Study description	This study examines the 8,011 amphibian species with an extinction risk assessment for the IUCN Red List of Threatened Species. Trends in extinction risk are quantified for 1980, 2004, and 2022 with comparisons between species in the different biogeographic realms, taxonomic orders, and breeding strategies. Estimates of extinction risk using current data are made for the species that were not known to science in 1980 and 2004. A particular focus of the study is the drivers of genuine extinction risk changes as these reflect actual increases or decreases in threat levels, some due to targeted conservation actions. These results are relevant to global, national, and local conservation planning and prioritisation, the National Biodiversity Action Plans (NBSAPs) reported to the Convention on Biological Diversity (CBD) of the United Nations to track progress towards the Kunming-Montreal Global Biodiversiy Framework adopted by 190+ signatory countries at COP15 in Montreal, Canada in December 2022.
Research sample	The sample size of this study includes 8,011 amphibian species known to science, representing 92.9% of described amphibians on the 3 May 2023 resubmission date.
Sampling strategy	The entire sample was used.
Data collection	Raw data collection took place between 2012-2022 resulting in IUCN Red List categories and their accompanying information for each species. This information comprises one of the two datasets in this study. This process involved more than 1,000 subject-matter experts through the consultation process described in the Methods section of the manuscript. Backcasting of the categories took place in 2022, which comprises the second dataset analysed in this study.
Timing and spatial scale	Data collection took place between 2012-2022. The data cover the taxonomy and geographic range of the 8,011 amphibian species in this study, i.e. every continent except Antarctica.
Data exclusions	No data were excluded.
Reproducibility	The data made available in the manuscript, Supplementary Information, and the data repository linked above enable the reproduction of all analyses and results.
Randomization	No randomisation was necessary for the analyses inf this study.
Blinding	Blinding was not relevant to this study.

Did the study involve field work? ☐ Yes ☒ No

Reporting for specific materials, systems and methods

We require information from authors about some types of materials, experimental systems and methods used in many studies. Here, indicate whether each material, system or method listed is relevant to your study. If you are not sure if a list item applies to your research, read the appropriate section before selecting a response.

Materials & experimental systems

n/a	Involved in the study
☒	☐ Antibodies
☒	☐ Eukaryotic cell lines
☒	☐ Palaeontology and archaeology
☒	☐ Animals and other organisms
☒	☐ Clinical data
☒	☐ Dual use research of concern
☒	☐ Plants

Methods

n/a	Involved in the study
☒	☐ ChIP-seq
☒	☐ Flow cytometry
☒	☐ MRI-based neuroimaging

Trends in Amphibian Occupancy in the United States

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Abstract

Though a third of amphibian species worldwide are thought to be imperiled, existing assessments simply categorize extinction risk, providing little information on the rate of population losses. We conducted the first analysis of the rate of change in the probability that amphibians occupy ponds and other comparable habitat features across the United States. We found that overall occupancy by amphibians declined 3.7% annually from 2002 to 2011. Species that are Red-listed by the International Union for Conservation of Nature (IUCN) declined an average of 11.6% annually. All subsets of data examined had a declining trend including species in the IUCN Least Concern category. This analysis suggests that amphibian declines may be more widespread and severe than previously realized.

Citation: Adams MJ, Miller DAW, Muths E, Corn PS, Grant EHC, et al. (2013) Trends in Amphibian Occupancy in the United States. PLoS ONE 8(5): e64347. doi:10.1371/journal.pone.0064347

Editor: Han Y. H. Chen, Lakehead University, Canada

Received February 19, 2013; **Accepted** April 12, 2013; **Published** May 22, 2013

Funding: The authors have no funding or support to report.

Competing Interests: The authors have declared that no competing interests exist.

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Introduction

Amphibians have received increasing attention since a crisis of declining populations was first recognized in the late 1980s [1–3]. In 2004, a comprehensive global assessment of amphibian status suggested that 32.5% of the world's species and 31.7% of the United States' species were declining [4]. The current extinction rate for amphibians has been estimated to be 211 times the background rate [5]. These numbers indicate that many species have conservation problems but they do not reveal the rate of population loss. Here, we use data from the U.S. Geological Survey's Amphibian Research and Monitoring Initiative (ARMI) to estimate the rate of change in the probability that amphibians occupy ponds and other comparable habitat features across the United States.

Documenting the rate of change in population parameters requires intensive studies that separate true changes in populations from changes in the probability of capture or detection when amphibians are present [6]. Such studies are relatively rare and it is unusual to have sufficient trend data to assess patterns at a national scale. The occupancy estimates produced by ARMI are statistically unbiased because they use repeated surveys to account statistically for the probability of detecting a species that is present [7]. Hence, our trend estimates based on these data are not influenced by changes in detection, though they rely on data points that each have associated error. Each occupancy estimate that we analyze applies to a species at a study area and each study area has a range of inference spanning tens to hundreds of sites. For heuristic purposes, the probability of site occupancy can be thought of as the expected proportion of sites occupied within the study area [7]. These occupancy estimates span a broad range of habitats, geographic areas (Figure 1A), and species including International Union for Conservation of Nature (IUCN) categories ranging from Endangered to Least Concern (Figure 1B).

Previous large analyses of amphibian time series relied on count data from individual populations [8–10]. We present the first broad assessment of amphibian trends to conform with a recommendation to document change in the number of populations rather than change in abundance [11].

Methods

We analyzed estimates of occupancy available at armi.usgs.gov. Each study within ARMI that generated these estimates used some form of repeated observation to detect amphibians [12–16]. An observation was usually a visual encounter survey but trapping and calling surveys were sometimes used for logistical reasons or to increase detection probability. Repeated observations were then used to estimate the proportion of sites where a species was present while accounting for imperfect detection [17]. Because the probability of detecting a species that is present is estimated and accounted for in each occupancy estimate, methods need not be

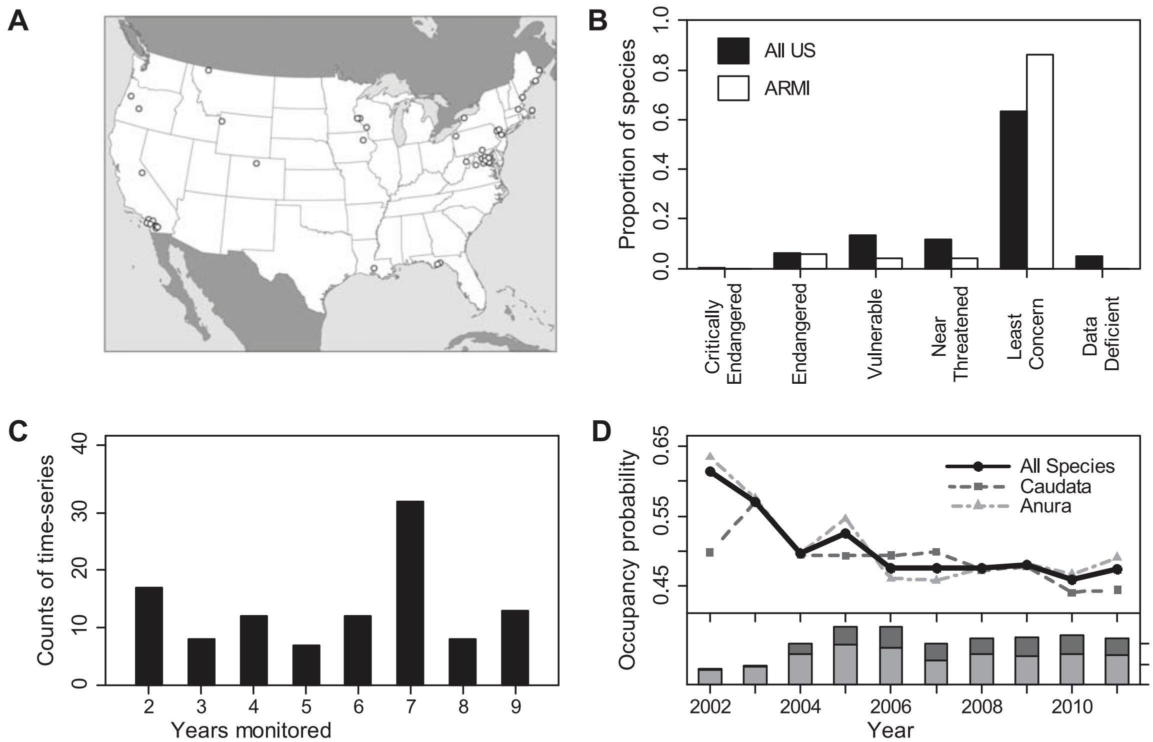

Figure 1. Characteristics of monitoring data. (*A*) Location of monitoring areas. (*B*) Distribution of species among IUCN categories. (*C*) Number of years monitored in each time series. (*D*) Mean annual estimates of probability of site occupancy and number of occupancy estimates (N).
doi:10.1371/journal.pone.0064347.g001

standardized across studies and any changes in detection probability over time will not bias trend estimates.

A site was a pond, watershed, plot, or for calling surveys, was the area within hearing distance of a point-survey location. A study area was the range of inference for a set of sites. Each study encompassed a variable number of sites that were monitored for the presence of target species. Multiple species of amphibian were monitored at many of the study areas. Each study generated annual estimates of occupancy using either a single-season occupancy estimator [17] or a multi-season dynamic occupancy model [18]. In the latter case, a form of model was used that estimates occupancy each year without imposing trends. We analyzed all time-series with two or more consecutive annual occupancy estimates (Figure 1C).

For our analysis of these occupancy estimates, we used generalized-linear mixed models to estimate mean occupancy each year and mean trends in occupancy for each time series of occupancy estimates. We fit models using the lme4 package [19] in the R programming language [20]. All models used a similar random effects structure with an among-time-series random effect to account for variation in mean occupancy (random intercept) and an among-time-series random effect for factors describing among year differences (random slope). Occupancy estimates were weighted by the inverse of their variance derived from their standard error. We replaced standard errors <0.04 with 0.04 so that no single occupancy estimate would be given disproportionate weight and to account for cases where standard errors were estimated poorly due to occupancy being close to 0 or 1.

To estimate mean occupancy each year, we treated year as a factor. To estimate mean trends over years, we treated year as a continuous covariate where year was standardized to have a mean of 0 for each time series. To compare trends among subsets of the data, we included a fixed effect for one of several grouping variables (IUCN category, taxon, geography, management agency). We allowed differences among groups in both the mean occupancy and the mean trend in occupancy across years. Models were run using a log-link function to estimate relative rates of change in occupancy over years. We report the annual rate of change which is e^{β}-1 where β is the instantaneous rate of change from the log-linear models. We used the delta method to obtain the SE for the annual rate of change. For comparison, we also ran models using an identity link to estimate absolute instantaneous changes in occupancy. We used likelihood-ratio tests (LRT) to evaluate the null hypothesis of no difference in trend among subsets of the data indicated by the grouping variables.

Results

From 2002 to 2011, ARMI generated 612 estimates of the probability of site occupancy for 108 time series (range 2 to 9 years, Figure 1C), including 45 species and 3 species complexes at 34 study areas. Mean annual estimates of occupancy generally decreased (Figure 1D), changing at a rate of -3.7% (SE = 1.5) annually across all time series (N = 108). All subsets of data that we examined showed a declining trend (Figure 2). The time series for species categorized as Least Concern by the IUCN (N = 96) had a mean annual trend of -2.7% (SE = 1.6), while time series for species in the Endangered, Vulnerable, and Near Threatened categories (N = 12) had a mean annual trend of -11.6% (SE = 4.3). Although the number of imperiled species is highest in the western U.S. [4,21], we did not find geographic differences in the rate of change in occupancy (LRT, $\chi^2_1 = 0.09$, p = 0.906 for East vs. West; LRT, $\chi^2_1 = 1.29$, p = 0.256 for North vs. South). We also did not find convincing differences between anurans and caudates (LRT, $\chi^2_1 = 0.21$, $p = 0.644$) or on lands managed by different agencies (LRT, $\chi^2_2 = 2.54$, $p = 0.280$). Conclusions did not differ when linear rather than log-linear models were fit (Table S1). We estimated trends for individual species using a separate model that treats species as a random effect (Table S2). However, data were sparse for most species and the strength of our analysis comes from examining mean trends across a large set of species and areas.

Discussion

Statistically unbiased estimates of the rate of change in amphibian patch occupancy are necessary to understand the scale and severity of amphibian losses [8,9]. They are particularly useful for species considered to be of Least Concern whose trends may be more subtle than for species determined to be imperiled at some level by the IUCN. An average loss of 2.7% of occupied sites each year for the species of Least Concern monitored by ARMI is alarming given that these species are thought to be relatively unaffected by global amphibian declines. This finding suggests that the IUCN threat status has been underestimated for some of these species. This is not a criticism of the IUCN effort, but illustrates the added value of statistically robust monitoring data to inform managers and policy makers.

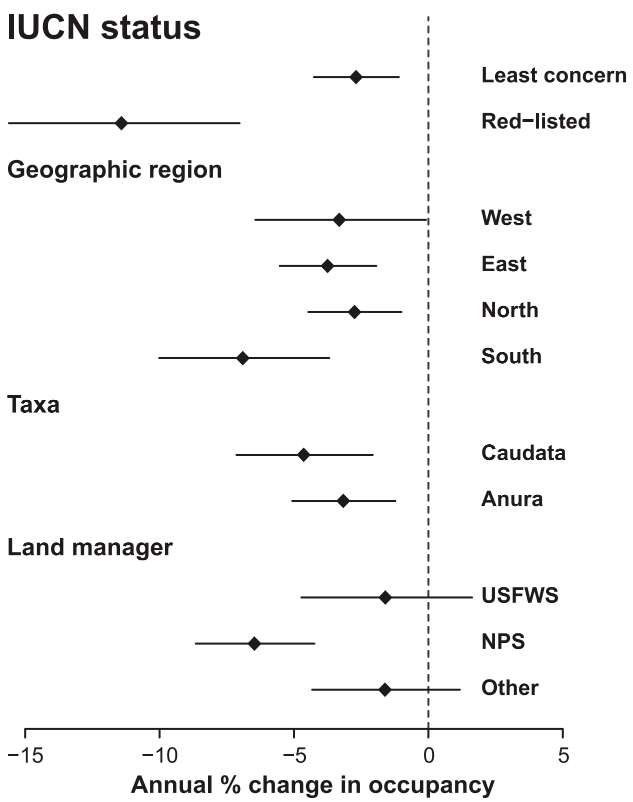

Figure 2. Rate of change in the probability of site occupancy for subsets data. "Red-listed" includes species that the IUCN categorizes as Near Threatened, Vulnerable, or Endangered. The geographic regions of the United States are overlapping and are North or South of 39° latitude or East or West of −104° longitude. Major land managers include the U.S. Fish and Wildlife Service (USFWS) and the National Park Service (NPS). Plotted values are means and standard errors.

doi:10.1371/journal.pone.0064347.g002

Sites sampled by ARMI were designed to be roughly equivalent to populations but the relationship between sites and populations is variable and not precisely known. We characterize our rate estimates as addressing change in the occupancy of habitat patches but in one study area the scale was small watersheds with an average of 8.6 ponds in each. Trends in occupancy should not be equated with trends in density [22]. Occupancy studies necessarily include occupied and unoccupied patches. Therefore, trends in occupancy reflect a process involving both local extinctions at occupied patches and colonization of unoccupied patches [18].

Primary hypotheses to explain global amphibian declines are land use change, disease, global climate change, and interactions of these factors with each other or with other stressors like contaminants or habitat degradation [23]. Anthropogenic habitat loss is rare at ARMI study areas. The fungal pathogen associated with chytridiomycosis is found throughout the US and is common in most [24,25] but not all [26] ARMI study areas where tested. Presence of the fungus resulted in reduced survival of adult amphibians in one study [27], but it is difficult to establish a direct link to declines in occupancy. Major die offs of amphibians were not observed in any of the studies analyzed here. The role of climate in changes in occupancy is difficult to evaluate for relatively short time series and we expect that patterns in occupancy caused by climate change will take years to become evident. The decade during which ARMI collected data experienced severe, but not unprecedented, drought [28]. Because most of the amphibians monitored rely on the presence of water for reproduction and development, precipitation patterns are an obvious hypothesis to explain changes in occupancy [16]. The relationship between occupancy trends and any potential driver is likely to vary across regions, habitats, and species necessitating careful specification of mechanisms prior to analysis of drivers.

Because the species and areas that ARMI monitors are not random, the declines we documented cannot be extrapolated directly to the rest of the U.S. or worldwide. This caveat also applies to all existing compilations of trends in amphibian abundance [8,9]. However, it is useful to consider how our trend estimates may compare to the larger population of species and areas in the U.S, which in most cases have larger distributions than our monitoring areas (armi.usgs.gov/national_amphibian_atlas.php). The species and areas monitored by ARMI were generally selected to evaluate the status and trends of amphibians on federally-managed lands at the scale of management units [29]. Such lands are sometimes perceived as better protected than private lands. In many cases, monitoring areas were selected to target a specific imperiled species but, by design, other local species were also monitored. Hence, our analysis includes a broad range of species that span most IUCN categories of endangerment (Figure 1B), but Least Concern species are overrepresented (86% compared to 63% nationally). Also, the first year of occupancy estimates was 2002, long after many severe declines are thought to have begun [9,30–32]. These factors are evidence that our analysis may underestimate the actual rate of amphibian losses in the United States. However, we emphasize that the true direction and magnitude of sampling bias is unknown and the relatively short time period monitored may not be representative of longer trends. We also note that our estimates of trends are based on estimates of occupancy that each have associated error (see armi.usgs.gov for SEs). Nonetheless, the trends we found represent the only broad assessment of population losses for amphibians in the U.S.

There is more than one way to estimate trends in occupancy estimates. We used log-linear models to estimate occupancy in a given year as a proportion of the previous year's occupancy. A change from 0.5 to 0.25 and a change from 0.1 to 0.05 both represent a 50% decline though the latter might involve a change in the occupancy status of a small number of sites relative to the former. As a result, similar absolute changes in occupancy influence estimates of trend more for areas where occupancy is low than for areas where occupancy is high. An alternative approach is to use linear models that estimate absolute changes in occupancy. Both methods are valid, but their sensitivity to extreme occupancy estimates and the interpretation of their estimates differ. For example, both methods suggest declines in all subsets of data examined (Table S1), but the distribution of trend estimates produced by log-linear models has a greater number of extreme negative estimates (Figure 3).

Conclusions

We provide a synthesis of a monitoring program that is unique in its national scope and use of statistically unbiased occupancy estimates. Our trend estimates are consistent with other analyses showing that amphibians are declining [4,8,9], and go further by suggesting that species for which there has been little conservation concern or assessment focus (e.g., common species) may also be declining. While there was some variation across the U.S., the trend was consistently negative. Furthermore, declines are occurring on lands managed by federal agencies with the greatest observed rate of decline on National Park Service lands where management policy prescribes protection of natural ecosystem processes. Overall, the trends we documented suggest that amphibian declines may be more widespread and severe than previously thought.

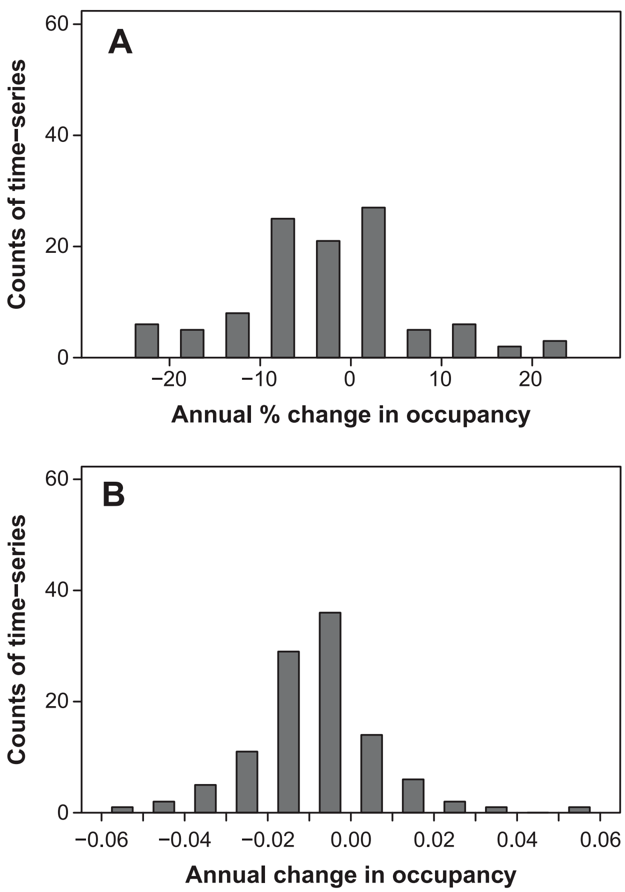

Figure 3. The distribution of trend estimates. Data are trends in the probability of site occupancy based on (*A*) log-linear and (*B*) linear models.
doi:10.1371/journal.pone.0064347.g003

Supporting Information

Table S1 Comparison of instantaneous trend estimates derived from linear and log-linear models of change in amphibian occupancy at ARMI monitoring areas, 2002–2011.
(DOC)

Table S2 Trends in the probability of site occupancy by species for ARMI monitoring areas, 2002–2011. The estimated trend effects are annual proportional changes in occupancy and are conditional on a random effect for a variable coding species that was included in the statistical model. Caution should be taken in interpreting results for individual species as data are generally sparse. The strength of our study comes from making inferences across a broad set of species and areas.
(DOCX)

Acknowledgments

Much of the ARMI data were collected in collaboration with one or more natural resource management agencies including the U.S. Fish and Wildlife Service, Bureau of Land Management, National Park Service, U.S. Forest Service, U.S. Department of Defense, or other entities. We thank L. Ball, R. Bury, K. Dodd, D. James, R. Kearney, J. Nichols, and C. Schwalbe for their role in the formation and direction of ARMI. We thank hundreds of people involved in collecting and maintaining ARMI data. In particular, A. Brand, B. Glorioso, B. Hossack, P. Kleeman, S. Mattfeldt, C. Pearl, M. Roth, W. Barichivich, D. Holmes, C. Rochester, C. Brown, A. Backlin, C. Brehme, S. Hathaway, E. Gallegos made major contributions. This manuscript benefited from suggestions by C. Eagle-Smith, J. Erickson, and W. Palen. This paper is contribution number 443 of the U. S. Geological Survey's Amphibian Research and Monitoring Initiative (ARMI). Any use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Author Contributions

Conceived and designed the experiments: MJA DAWM EM PSC EHCG LLB GMF RNF WJS HW SCW. Analyzed the data: MJA DAWM EHCG. Wrote the paper: MJA DAWM. Commented on the manuscript: EM PSC EHCG LLB GMF RNF WJS HW SCW.

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Attachment H

Comments on the Draft Environmental Impact Statement for the Yazoo Backwater Area Water Management Project, June 2024

Submitted by

National Wildlife Federation, National Audubon Society, Sierra Club
Audubon Delta, Healthy Gulf, Sierra Club Mississippi

August 27, 2024

November 30, 2020

District Engineer
U.S. Army Corps of Engineers
Vicksburg District
4155 Clay Street
Vicksburg, Mississippi 39183-3435

USACE—Vicksburg District,

Today, I, James Godwin, a member of a contingent of biologists specializing in turtles, write to express my deepest concerns regarding the ecological impacts of a proposed project by the U.S. Army Corps of Engineers (USACE) to reduce the impacts of flooding within the Yazoo Backwater Area. Of particular concern is the impact the proposed project will have on the wetland and floodplain ecosystem of Lake George Wildlife Management Area and Panther Swamp National Wildlife Refuge. Following an in-depth review of the Environmental Impact Statement for the proposed project, it is our position that the floodwater mitigation measures presented will cause a profoundly negative impact on the wetland ecosystem, its inhabitants, and connectivity of these river systems to their adjacent floodplains.

Amongst the most unique wildlife inhabiting Lake George WMA and Panther Swamp NWR is the Western Alligator Snapping Turtle (AST) (*Macrochelys temminckii*), listed as Vulnerable in Mississippi and a candidate species for federal protection under the US Endangered Species Act. The population of Western Alligator Snapping Turtles within the above-mentioned locations is of paramount conservation value as population numbers of the species continue to decline range wide (Huntzinger et al. 2019; Lovich et al. 2018; Munscher et al. 2020). The AST population within Panther Swamp NWR, and the adjacent Lake George WMA, is among the largest and most demographically robust population in Mississippi (L. Pearson, pers. comm) and constitutes a vital component of the Southern Mississippi – East Analysis Unit for the species. Furthermore, as of 2020, the Panther Swamp NWR population represents the only known refugia in Mississippi, and one of very few across the AST's geographic range, which has escaped the impacts of human harvest. This makes it among the least-impacted populations persisting today (Huntzinger et al. 2019; L. Pearson et al. 2019, pers. comm).

The proposed draining of wetlands and floodplain habitats would directly impact this AST population, as the single largest tract of land to be drained is the 8,000-acre Lake George WMA (mitigation land for wetland losses caused by previously constructed federal flood control projects). This WMA sits adjacent to Panther Swamp NWR, where several thousand more acres, and its wildlife, will be impacted.

For species like and including the AST, their natural histories predispose them to greater adverse impacts from flood control measures. The AST predominantly uses connective waterbodies for movement (Harrel et al. 1996, Riedle et al. 2006, Sloan and Taylor 1987). While many freshwater turtle species may make terrestrial movements to seek out new or differing waterbodies, the AST does not. The only overland movements made by the AST are by nesting females, typically moving a maximum distance of 200 meters from the closest water body to deposit their eggs (Ewert 1976, Pritchard 2006). Limited overland movement coupled with draining of wetland and floodplain forests would substantially limit annual access to floodplain resources for the Alligator Snapping Turtle. In consequence, impacts to waterbodies used by this candidate species could further push it towards federal listing under the US Endangered Species Act.

The significance of the AST population inhabiting Panther Swamp NWR, and the adjacent Lake George WMA, was recently determined in 2020. The population is considered one of the largest in Mississippi, and population demographics (i.e., very large adults and several juveniles) are consistent with minimal impacts of human harvest (L. Pearson et al. *in prep*). It is likely that the Panther Swamp NWR AST population is doing so well, when other populations are declining, due to access of floodplain resources that occur with annual flood events.

My concerns in particular are:

- Removing the connectivity of these river systems to the adjacent floodplains within Lake George WMA and Panther Swamp NWR would negatively impact the AST population by removing access to a significant amount of resources.

- Removal of these floodplain resources would negatively impact growth, reproductive output, and recruitment into a population residing in one of the last untouched refugia for the species in the country. Additionally, recent research highlights that highly altered aquatic habitats equate to reduced turtle community species richness, including decreasing AST populations (L. Pearson, pers. comm).

- Stating that "conversion of wetlands to non-wetlands is not anticipated" based on a single and inconclusive study is irresponsible. Berkowitz et al.'s (2019) conclusion that 87% of wetlands would persist in the absence of flooding is based on extremely limited monitoring of 44 sites for less than one year, and 12 sites monitored between three and eight years. Longer duration studies are needed to determine if this conclusion is truly accurate before the installation of 14,000 CFS pumps that will directly impact up to 200,000 acres of wetlands.

- Even if the Yazoo Backwater Pump Project was operational in 2019, there would have been a 35% reduction in flooded acreage, with only 500 acres of developed land being drained. However, between 60,000 and 70,000 acres of wetlands crucial to wildlife would have been drained, including the floodplains of Panther Swamp NWR and Lake George WMA.

As part of a scientific and conservation collective, I strongly oppose the Yazoo Backwater Area Pump Project. However, should it be adopted, funding needs to be provided to assess baseline demographics and floodplain habitat use of this unique AST population. Through this research, continued monitoring of the population during and post-pump construction would help determine the impacts of reduced access to floodplain resources on a population of long-lived, and potentially endangered, turtles. Projected losses should require mitigation and preservation of suitable habitat for the Western Alligator Snapping Turtle.

I encourage USACE to give more consideration to alternatives having a less direct impact on the natural qualities of Panther Swamp NWR and Lake George WMA and that preserve its unique biodiversity.

Sincerely,

James Godwin
Alabama Natural Heritage Program
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334-844-5020

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November 30, 2020

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- Stating that “conversion of wetlands to non-wetlands is not anticipated” based on a single and inconclusive study is irresponsible. Berkowitz et al.’s (2019) conclusion that 87% of wetlands would persist in the absence of flooding is based on extremely limited monitoring of 44 sites for less than one year, and 12 sites monitored between three and eight years. Longer duration studies are needed to determine if this conclusion is truly accurate before the installation of 14,000 CFS pumps that will directly impact up to 200,000 acres of wetlands.

- Even if the Yazoo Backwater Pump Project was operational in 2019, there would have been a 35% reduction in flooded acreage, with only 500 acres of developed land being drained. However, between 60,000 and 70,000 acres of wetlands crucial to wildlife would have been drained, including the floodplains of Panther Swamp NWR and Lake George WMA.

As part of a scientific and conservation collective, I strongly oppose the Yazoo Backwater Area Pump Project. However, should it be adopted, funding needs to be provided to assess baseline demographics and floodplain habitat use of this unique AST population. Through this research, continued monitoring of the population during and post-pump construction would help determine the impacts of reduced access to floodplain resources on a population of long-lived, and potentially endangered, turtles. Projected losses should require mitigation and preservation of suitable habitat for the Western Alligator Snapping Turtle.

I encourage USACE to give more consideration to alternatives having a less direct impact on the natural qualities of Panther Swamp NWR and Lake George WMA and that preserve its unique biodiversity.

Sincerely,

Jordan Gray
Turtle Survival Alliance
1030 Jenkins Rd., Ste. D
Charleston, SC 29407
(912) 659-0978

Literature Cited

Berkowitz, J.F., Johnson, D.R., and Price, J.J. 2019. Forested wetland hydrology in a large Mississippi River tributary system. Wetlands 40:1 – 16.

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Sloan, K.N. and Taylor, D. 1987. Habitats and movements of adult alligator snapping turtles in Northeast Louisiana. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 41: 343 – 348.

November 30, 2020

District Engineer
U.S. Army Corps of Engineers
Vicksburg District
4155 Clay Street
Vicksburg, Mississippi 39183-3435

USACE—Vicksburg District,

Today, I, Luke Pearson, a member of a contingent of biologists specializing in turtles, write to express my deepest concerns regarding the ecological impacts of a proposed project by the U.S. Army Corps of Engineers (USACE) to reduce the impacts of flooding within the Yazoo Backwater Area. Of particular concern is the impact the proposed project will have on the wetland and floodplain ecosystem of Lake George Wildlife Management Area and Panther Swamp National Wildlife Refuge. Following an in-depth review of the Environmental Impact Statement for the proposed project, it is our position that the floodwater mitigation measures presented will cause a profoundly negative impact on the wetland ecosystem, its inhabitants, and connectivity of these river systems to their adjacent floodplains.

Amongst the most unique wildlife inhabiting Lake George WMA and Panther Swamp NWR is the Western Alligator Snapping Turtle (AST) (*Macrochelys temminckii*), listed as Vulnerable in Mississippi and a candidate species for federal protection under the US Endangered Species Act. The population of Western Alligator Snapping Turtles within the above-mentioned locations is of paramount conservation value as population numbers of the species continue to decline range wide (Huntzinger et al. 2019; Lovich et al. 2018; Munscher et al. 2020). The AST population within Panther Swamp NWR, and the adjacent Lake George WMA, is among the largest and most demographically robust population in Mississippi (L. Pearson, pers. comm) and constitutes a vital component of the Southern Mississippi – East Analysis Unit for the species. Furthermore, as of 2020, the Panther Swamp NWR population represents the only known refugia in Mississippi, and one of very few across the AST's geographic range, which has escaped the impacts of human harvest. This makes it among the least-impacted populations persisting today (Huntzinger et al. 2019; L. Pearson et al. 2019, pers. comm).

The proposed draining of wetlands and floodplain habitats would directly impact this AST population, as the single largest tract of land to be drained is the 8,000-acre Lake George WMA (mitigation land for wetland losses caused by previously constructed federal flood control projects). This WMA sits adjacent to Panther Swamp NWR, where several thousand more acres, and its wildlife, will be impacted.

For species like and including the AST, their natural histories predispose them to greater adverse impacts from flood control measures. The AST predominantly uses connective waterbodies for movement (Harrel et al. 1996, Riedle et al. 2006, Sloan and Taylor 1987. While many freshwater turtle species may make terrestrial movements to seek out new or differing waterbodies, the AST does not. The only overland movements made by the AST are by nesting females, typically moving a maximum distance of 200 meters from the closest water body to deposit their eggs (Ewert 1976, Pritchard 2006). Limited overland movement coupled with draining of wetland and floodplain forests would substantially limit annual access to floodplain resources for the Alligator Snapping Turtle. In consequence, impacts to waterbodies used by this candidate species could further push it towards federal listing under the US Endangered Species Act.

The significance of the AST population inhabiting Panther Swamp NWR, and the adjacent Lake George WMA, was recently determined in 2020. The population is considered one of the largest in Mississippi, and population demographics (i.e., very large adults and several juveniles) are consistent with minimal impacts of human harvest (L. Pearson et al. *in prep*). It is likely that the Panther Swamp NWR AST population is doing so well, when other populations are declining, due to access of floodplain resources that occur with annual flood events.

My concerns in particular are:

- Removing the connectivity of these river systems to the adjacent floodplains within Lake George WMA and Panther Swamp NWR would negatively impact the AST population by removing access to a significant amount of resources.

- Removal of these floodplain resources would negatively impact growth, reproductive output, and recruitment into a population residing in one of the last untouched refugia for the species in the country. Additionally, recent research highlights that highly altered aquatic habitats equate to reduced turtle community species richness, including decreasing AST populations (L. Pearson, pers. comm).

- Stating that "no conservation of wetlands to non-wetlands" would occur based on a single and inconclusive study is irresponsible. Berkowitz et al.'s (2019) conclusion that 87% of wetlands would persist in the absence of flooding is based on extremely limited monitoring of 44 sites for less than one year, and 12 sites monitored between three and eight years. Longer duration studies are needed to determine if this conclusion is truly accurate before the installation of 14,000 CFS pumps that will directly impact up to 200,000 acres of wetlands.

- Even if the Yazoo Backwater Pump Project was operational in 2019, there would have been a 35% reduction in flooded acreage, with only 500 acres of developed land being drained. However, between 60,000 and 70,000 acres of wetlands crucial to wildlife would have been drained, including the floodplains of Panther Swamp NWR and Lake George WMA.

As part of a scientific and conservation collective, I strongly oppose the Yazoo Backwater Area Pump Project. However, should it be adopted, funding needs to be provided to assess baseline demographics and floodplain habitat use of this unique AST population. Through this research, continued monitoring of the population during and post-pump construction would help determine the impacts of reduced access to floodplain resources on a population of long-lived, and potentially endangered, turtles. Projected losses should require mitigation and preservation of suitable habitat for the Western Alligator Snapping Turtle.

I encourage USACE to give more consideration to alternatives having a less direct impact on the natural qualities of Panther Swamp NWR and Lake George WMA and that preserve its unique biodiversity.

Sincerely,

Luke Pearson
118 College Drive #5018
University of Southern Mississippi
Hattiesburg, MS 39406
501-772-8455

Literature Cited

Berkowitz, J.F., Johnson, D.R., and Price, J.J. 2019. Forested wetland hydrology in a large Mississippi River tributary system. Wetlands 40:1 – 16.

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November 30, 2020

District Engineer
U.S. Army Corps of Engineers
Vicksburg District
4155 Clay Street
Vicksburg, Mississippi 39183-3435

USACE—Vicksburg District,

Today, I, **Madalyn Van Valkenburg**, **a concerned Mississippi resident**, write to express my deepest concerns regarding the ecological impacts of a proposed project by the U.S. Army Corps of Engineers (USACE) to reduce the impacts of flooding within the Yazoo Backwater Area. Of particular concern is the impact the proposed project will have on the wetland and floodplain ecosystem of Lake George Wildlife Management Area and Panther Swamp National Wildlife Refuge. Following an in-depth review of the Environmental Impact Statement for the proposed project, it is our position that the floodwater mitigation measures presented will cause a profoundly negative impact on the wetland ecosystem, its inhabitants, and connectivity of these river systems to their adjacent floodplains.

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I encourage USACE to give more consideration to alternatives having a less direct impact on the natural qualities of Panther Swamp NWR and Lake George WMA and that preserve its unique biodiversity.

Sincerely,
Madalyn Van Valkenburg
914 Morningside Street Apt D2
Jackson, MS 39202
(501)772-8140

Literature Cited

Berkowitz, J.F., Johnson, D.R., and Price, J.J. 2019. Forested wetland hydrology in a large Mississippi River tributary system. Wetlands 40:1 – 16.

Ewert, M.A. 1976. Nests, nesting, and aerial basking of *Macroclemys* under natural conditions, and comparisons with *Chelydra* (Testudines: Chelydridae). Herpetologica 32:150-156.

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Attachment I

Comments on the Draft Environmental Impact Statement for the Yazoo Backwater Area Water Management Project, June 2024

Submitted by

National Wildlife Federation, National Audubon Society, Sierra Club
Audubon Delta, Healthy Gulf, Sierra Club Mississippi

August 27, 2024

From: [redacted]
To: [redacted]
Subject: [Non-DoD Source] RE: 2011 Impacted Homes
Date: Monday, November 27, 2023 12:11:03 PM

Yes, that is correct for the most part. We lost most of those files that were done electronically, but we do probably have some paper files on them, but most were either raised or demolished, same with the backwater losses too. There were some buyouts and those were demolished.

[redacted]

[redacted]
Director
Warren County Emergency Management
Warren County Permit Official
Floodplain Administrator
601-636-1544
[redacted]
Fax 601-636-3080

From: [redacted]
Sent: Monday, November 27, 2023 10:47 AM
To: [redacted]
Subject: 2011 Impacted Homes

[redacted]

I had a quick question about homes that were flooded in the 2011 MS River Flood. You might not be the person for this question and maybe can direct me to whom could help.

We are working on the Yazoo Backwater Pump project again and we are getting the question of impacts to people downstream and it was mentioned the homes that flooded in 2011. I started looking into impacts of the pump during an event and I was told through third hand knowledge that the homes that flooded (I think the Kings Community was mentioned) in 2011 have all been raised or bought out. So if a 2011 event were to occur today then none of the homes would be flooded or flooded with people inhabiting those homes.

Can you confirm or deny that third hand statement or put me in touch with someone who would know that information? Thanks for your help.

[redacted]

Attachment J

Comments on the Draft Environmental Impact Statement for the Yazoo Backwater Area Water Management Project, June 2024

Submitted by

National Wildlife Federation, National Audubon Society, Sierra Club
Audubon Delta, Healthy Gulf, Sierra Club Mississippi

August 27, 2024

William E. Fleenor, Ph.D.
EDL Consultants, LLC
2367 Banks Drive
Woodland, CA 95776
(530) 219-2351

Analysis of the HEC-RAS 1D Model Used by the U.S. Army Corps of Engineers in Assessment of their report: "*Impacts of the Yazoo Backwater Pumps to Downstream Stages 22 November 2019*"

November 1, 2020

Executive Summary

The U.S. Army Corps of Engineers used a one-dimensional hydrodynamic HEC-RAS model[1] to assess the downstream impacts of the Yazoo Backwater Pumps on water elevations (stage) in the Yazoo River during the peak 2019 event. Review of that Model demonstrates that it is not capable of accurately examining stage changes in the Yazoo River because it provides a poor and very inaccurate representation of the Yazoo River, does not properly match measured stages and flows, uses obviously inappropriate boundary conditions, and is not sufficiently calibrated.

More specifically, the Model represents the lower reach of the Yazoo River (the area most likely to be affected by the Yazoo Pumps) as being 17.5 miles, or 37.5%, longer than it actually measures, and this added length alone disqualifies the Model from being reliable. The Model also includes many cross-sections for the Yazoo River that are wider than justified, which results in the Model producing a Yazoo River that can convey more water than reality. The Model demonstrates extraordinarily little tendency to match the amount of timing of the measured flow in the lower reach of the Yazoo River, with the modeled flows at

[1] This model, referred to in this report as the Model or the 1-D Model, utilizes both Mississippi River reaches, and tributary Yazoo River reaches.

the USGS Redwood gage location (the closest upstream gage to the proposed location of the Yazoo Pumps) often peaking while flows measured by the Redwood gage are in a trough, and the six-month simulation of the Model producing modeled flow at the Redwood gage with 76.2 billion cubic feet less than measured by that gage. Due to the use of inappropriate flow boundary conditions, the Model predicts stage and flow levels that do not match the levels measured by gages in 2019. The base model performance of stage and flow at Yazoo River gages indicates that the Model was not calibrated and thus cannot be trusted to get a correct answer under any type of changes, such as the additional flows generated by the pumps.

The Model must be more accurately defined, and the boundary conditions better established before the Model can be properly calibrated, and then used to assess the impacts of the Yazoo Backwater Pumps. Use of a two-dimensional model would provide a much better assessment of stage elevations in the primary area of interest due to many of the flows being across the main Yazoo River channel and the crossflow area from the Mississippi River.

Introduction

This report summarizes the findings of my review of the one-dimensional hydrodynamic HEC-RAS model (the “1-D Model”) used by the U.S. Army Corps of Engineers (“USACE”) to develop their report entitled: “*Impacts of the Yazoo Backwater Pumps to Downstream Stages 22 November 2019*” (the USACE 2019 Report”). The stated purpose of the USACE 2019 Report is to summarize the findings of the USACE modeling regarding the impact on downstream stages had the Yazoo Backwater Pumps been in operation during the 2019 flood event.

The Yazoo River is a mild slope system that flows from its origin at the confluence of the Tallahatchie and Yalobusha rivers north of Greenwood, MS to its confluence with the Mississippi River at Vicksburg, MS. As noted in the USACE 2019 Report, high stages (*i.e.* water levels) on the Mississippi River cause flow to back up the Yazoo River, causing higher stages in the Yazoo

River. The 14,000 cfs Yazoo Backwater Pumps would be operated during high stages on the Mississippi River, discharging significant amounts of water into the Yazoo River. Given these conditions, a model must accurately represent both the Mississippi and Yazoo Rivers to correctly predict changes in stage resulting from operation of the Yazoo Pump; upstream or downstream model errors for either river could potentially skew results and obscure the effects of the Yazoo Pumps.

Proper representation of the stage at the confluence of the Mississippi and Yazoo Rivers is particularly essential for obtaining accurate results on the Yazoo River. First, in mild slope systems, the downstream stage controls the effects upstream. Second, it is essential that the inflow boundaries accurately reflect the actual flows to recreate the measured flows. "*Having good boundary conditions is imperative in any type of land surface and riverine modeling*." (HEC 2020).

Methods

The five-page USACE 2019 Report provides virtually no description of the model used, stating only that the model is a calibrated tool developed as part of the MR&T flowline assessment and providing no direct information regarding that calibration. Accordingly, requests were made to the Corps to provide the model and supporting documentation and materials, including the calibration report and projection file. Materials provided by the Corps were then analyzed, and assumptions used to assess the 1-D Model were documented.

It appears that the domain of the 1-D Model supplied by USACE was clipped from a larger domain of the Corps Water Management System (CWMS) model. The upstream flow boundary conditions on the Mississippi River and Yazoo River are also likely extracted from the CWMS model since no flow gages are co-located at the exact boundaries.

As noted, requests were made for the calibration report for the 1-D Model. However, neither the study provided by USACE in response to this request nor any of the other Mississippi River Geomorphology and Potamology Program (MRG&P) reports located include any actual documentation of the calibration of the 1-D Model.

The 1-D Model as supplied by USACE had been simulated with version 5.0.3 of the HEC-RAS code; the model supplied by USACE would not run under the current version of HEC-RAS, 5.0.7. The current, newer version of the code includes an increasing number of checks on the network to point out errors in the network.

The USACE 2019 Report does not provide a vertical datum for the work (assumed to be the older NGVD29 datum), nor a projection file for the georeferenced network of the model. A projection file was eventually supplied after repeated requests. Use of the projection file demonstrates many errors along the Yazoo River model network, while the Mississippi River appears reasonably well represented. However, neither the boundary conditions for the Yazoo River or the Mississippi River produce stage or flow levels that match the measured data for any of the internal gages operating in 2019.

Analysis

The following analysis and Appendix document my review of the 1-D Model that was provided by USACE in response to a request for the USACE model used to assess the downstream stage consequences of the Yazoo Backwater Pumps.

The Model Does Not Appear to Be Calibrated

The USACE 2019 Report states that it used a calibrated model, but that report provides no information on the calibration. Calibration documentation was requested on several occasions but was not provided. As discussed below, the base model performance of stage and flow at both the Mississippi and Yazoo River gages indicate that the Yazoo River model was not calibrated.

As stated in the USACE Hydrologic Engineering Center (HEC) report, Modeler Application Guidance for Steady vs Unsteady, and 1D vs 2D vs 3D Hydraulic Modeling, "*Calibration of any hydraulic model is required in order to understand if the model is capable of reproducing past floods, and if it can predicting future flood events with confidence*." (HEC 2020, grammatical errors in original). Indeed, the need to properly calibrate a numerical model cannot be overstated, as clearly explained in the following excerpt from the HEC Guidelines (2020): "*The model calibration process is one of the most important steps in the development of a hydraulic model. Calibration of any hydraulic model is required in order to understand if the model is capable of reproducing past floods, and if it can predicting future flood events with confidence. The calibration process also allows for greater understanding of the models sensitivity to the data, friction forces, and other empirical coefficients. A model that is not calibrated is just a numerical experiment*." (HEC 2020, grammatical errors in original).

A Two-Dimensional Model Would Provide A Much Better Assessment

The USACE 2019 Report (Figure 1 in that report) uses outputs from a two-dimensional model to evaluate flow patterns during high flow events at the confluence of the Mississippi and Yazoo Rivers just above Vicksburg, MS. That two-dimensional model shows that substantial flow occurs upstream on the Yazoo River and west-to-east across the lower floodplain between the two rivers. These flow patterns suggest that the use of a 1D model is questionable for the lower Yazoo River. As stated in HEC guidance, *"When the equations of motion are derived in a one-dimensional form, it is under the assumption that the forces acting on a body of water are predominant in one direction, x, along the river channel centerline.*" The guidance thus warns that *"if the flow path of the water can change significantly during the event, 2D modeling approaches can handle this, whereas 1D modeling approaches cannot*." (HEC 2020).

The Model Does Not Utilize the Most Up To Date Software

The 1-D Model and data provided, and the USACE 2019 Report indicate that the 1-D Model was simulated using version 5.0.3 of the software. Newer software versions have progressively added internal checks to check the network for errors. Using the latest version of HEC-RAS, the model throws 2 fatal errors (Appendix Fig. 5) preventing it from running the simulation. Both errors involved improperly specified lateral weir structures where two weirs overlapped each other, which would result in the double counting of water flowing over each weir. While the Mississippi River network is relatively complete and well-defined, the Yazoo River has sparse cross-sections (Appendix Fig. 11) and many of these cross-sections also have design issues as shown by the newer version of the software (Appendix Fig. 6).

Yazoo River

The Yazoo River network of the model is too poorly implemented to judge whether it could accurately predict the stage changes with and without the pumps. The network poorly represents the river channel and most of the cross-sections are interpreted from widely spaced, user-specified cross-sections (see Appendix Fig. 11). The lower reach of the model extends approximately 46.5 miles upstream from the confluence with the Mississippi River extending upstream to the confluence with the W-WIT[2] reach and covers the primary area of interest. The individual distances from cross-section to cross-section in the model sum to 64 miles. It is these distances that are used in the mathematics of the model. That makes the lower river reach in the Model 17.5 miles longer than it should be, or 37.5% longer. Overall, the Yazoo River cross-sections add up to over 24.5 miles longer than the actual river distance to the upper boundary in the model, so most of the errors are in the reach of greatest interest. The added length alone would disqualify the model from being credible. If it were calibrated under these conditions it could not be trusted to get a correct answer under any type of changes, such as the additional flows generated by the pumps. The base

[2] No other information was provided about the channel.

model performance of stage and flow at Yazoo River gages indicates that the model was not calibrated.

The upper flow boundary condition on the Yazoo River cannot be confirmed. Adding Yazoo River inflow to the inflow from the Mississippi River, the sum does not agree with the measured flows at Vicksburg, either for instantaneous flows or total volume over time (Appendix Fig. 9). The instantaneous values would certainly be difficult to match since the lower Yazoo River is so much longer than reality; but the excess length would not influence flow volumes over time, so definite errors exist in one or both of the boundary input flows. Many of the cross-sections on the Yazoo River have bank stations wider than can be justified (Appendix Fig. 15 & 16). Overestimated bank widths would produce additional conveyance, but the roughness coefficient used for the lower reach is quite high and would reduce conveyance. It is unclear without a calibration report whether the roughness was increased to account for the overbank areas that are included in the channel or just some other type of calibration effort.

Examining stages along the Yazoo River against the model demonstrates that upstream predictions (at Greenwood and Shell Bluff) are 1-4 ft above the recoded values (Appendix Fig. 20). In the mid ranges of the Yazoo River (at Belzoni, Yazoo City, and Satartia) the predictions are 1-6 ft below the recoded gages (Appendix Fig. 21, 22, & 23). In the lower section of the river the model at Redwood the model prediction of stages is within the 0.5 ft tolerance mentioned in the Corps report, but only on 122 days of the 180-day simulation (Appendix Fig 24). The directional change of the modeled errors led to discovering a major cross-section error at cross-section 134.71 which in turn was used to have the model interpret the next 7 cross-sections downstream. Repairing the error still does not bring the upper and middle reaches into anything that would represent a calibrated reach.

The closest upstream flow gage to the proposed location of the Yazoo

Pumps found on the modeled section of the Yazoo River is at Redwood and the model demonstrates extraordinarily little tendency to match the measured flow with a 23.7% average daily error (Appendix Fig. 25). Often the modeled flows are peaking while the measured flows are in a trough; and during the six-month simulation of the model the modeled flow at Redwood is 76.2 billion cubic feet less than measured by the USGS gage.

There is a second USGS gage below the Steel Bayou Control Structure which also confirms the poor flow representation of the model, with the peak flow being just over 50% of the measured peak flow (Appendix Fig. 28). Both the Redwood gage and the gage below the Steel Bayou Control Structure follow the measured stage patterns, demonstrating how strongly the boundary condition with the Mississippi River influence the lower Yazoo River. However, the average modeled daily stage error at Redwood is still 0.42 ft and exceeds the allowable 0.5 ft USACE tolerance over 30% of the 180 days modeled.

Mississippi River

The Mississippi River network in the model is much better defined. Most cross-sections are user defined and appear to properly define the river. The upper boundary condition cannot be confirmed since there is no actual gage co-located with the boundary. As stated above, the flow, plus the Yazoo River flow, does not sum to the flow measured at Vicksburg. It cannot be determined if the Yazoo is the only error, or if both contribute to the error at Vicksburg. The modeled flow at Vicksburg is nearly 100,000 cfs less at the peak than the measured flow (Appendix Fig. 1). Modeled peak flow duration is over a week shorter than measured flow duration, while the modeled stage duration is over a week longer. Both results emphasize errors in the flow boundary conditions on one or both inflows and likely some of the network issues on the Yazoo River.

The lower stage boundary condition on the Mississippi River does not match the gage values (Appendix Fig. 2) and the flow in the model is much lower than measured. It is not evident that these errors would contribute to further errors on the Yazoo River. The main influence on the Yazoo River, other than the flow boundary condition, would be the stage at the confluence of the two rivers, and the crossflow from the Mississippi River to the Yazoo River above that confluence. The confluence is just upstream from Vicksburg where the model does a poor job of matching flow and stage. There are no recorded data to assess the crossflow, so the problem is not well-defined without a better Yazoo River network and boundary conditions that could properly match the Vicksburg observations.

The outflow at the lower Mississippi is equal to the sum of the two boundary inflows (Appendix Fig. 3), so no additional inflows were included in the model. Overall, the results on the Yazoo River are dependent on the boundary inflow, the stage and flow at the confluence of the two rivers, along with the crossflow, so the errors on the Mississippi River below Vicksburg would not be expected to affect the Yazoo River results.

Conclusions

The one-dimensional hydrodynamic HEC-RAS model used by USACE to assess the downstream impacts of the Yazoo Backwater Pumps on water elevations (stage) must be more accurately defined, and the boundary conditions better established before the model can be properly calibrated and then used to assess the impacts of the Yazoo Backwater Pumps. The Model provided by USACE is not capable of accurately examining stage changes in the Yazoo River because it provides a poor and very inaccurate representation of the Yazoo River, does not properly match measured stages and flows, uses obviously inappropriate boundary conditions, and is not sufficiently calibrated. Use of a two-dimensional model would provide a much better assessment of stage elevations in the primary area of interest due to many of the flows being across the main river channel and the crossflow area.

References

HEC, 2020, *Modeler Application Guidance for Steady vs Unsteady, and 1D vs 2D vs 3D Hydraulic Modeling*, U. S. Army Corps of Engineering Hydrologic Engineering Center, August 2020

USACE, 2019, *Impacts of Yazoo Backwater Pump to Downstream Stages 22 November 2019*, U. S. Army Corps of Engineers, November 2019

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Appendix

Boundary Conditions

The Mississippi River inflow is listed as being located at Arkansas City, but the model network does not actually start at that geographic location, nor does the USGS gage at that site provide flow data – only stage. The DSS data input files provided with the model also contain a file for Vicksburg flow for the study period. All data included in the file are designated as DCP-REV values. I cannot identify the revised nature of this source or any other flow values for the inflow boundaries. The two upstream boundary conditions do not sum to the flow listed in the DCP-REV Vicksburg file in the input data or the USGS gage data. If the Vicksburg file is correct, then water is being impounded in the storage areas or the boundary flows are too low. The difference is over 800 billion cubic feet of water.

Neither the sum of the boundary conditions nor the DCP-REV Vicksburg flow has flow rates as high as the actual flows reported by the USGS at Vicksburg (see Fig. 1).

No lateral inflows along the Mississippi River are included. Using stage alone is suitable for the lower boundary condition for the project but is done in a rather strange manner by holding the Old River outflow control at 300,000 cfs and letting the balance flow down the Mississippi River. Since the lower boundary condition is controlled by the specified stage, the handling of the flow should not affect the results. The values used for the lower stage elevations cannot be explained from the data. The value input is assumed to be at the Red

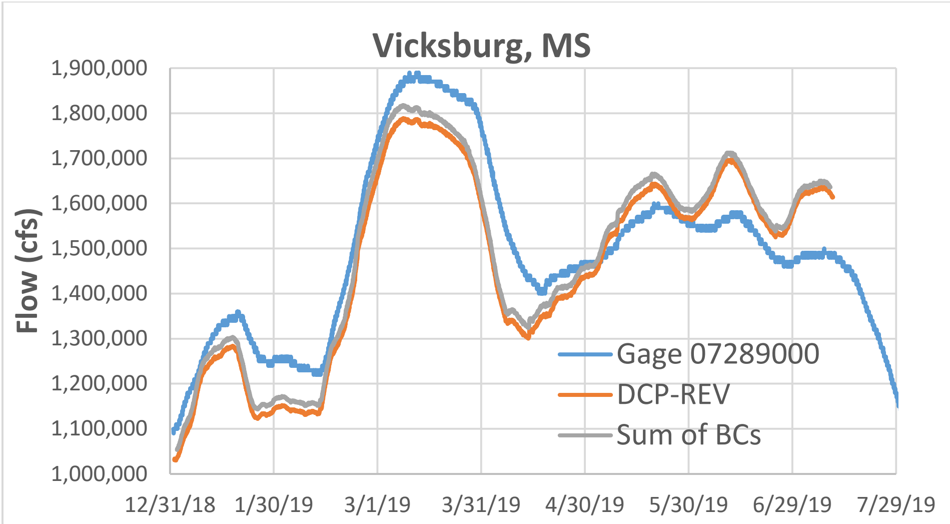

Figure 1 Comparison of DPC-REV Vicksburg and gage data with sum of boundary conditions.

River gage location as specified in the model cross-section description. However, the values input into the model vary by -2 to +4 feet from the USGS gage data (see Fig. 2). These errors, along with the lack of lateral inflows from Vicksburg to the lower model boundary will result in stage errors below Vicksburg. These errors will translate into flow errors through the model domain.

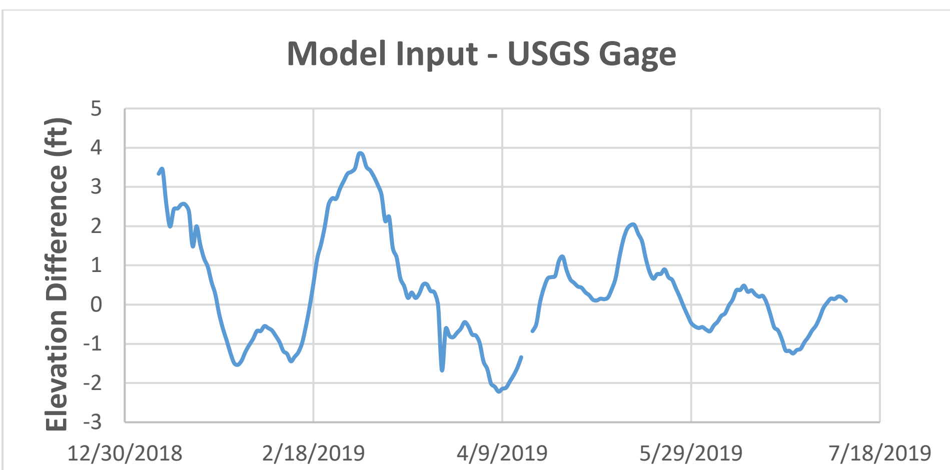

Figure 2 Difference between model input and USGS gage data at the lower boundary.

At the lower boundary of the model, Red River Landing, flow in the model was compared to the sum of Mississippi River flow at Talbert and the Old River flows. It is clear that no lateral inflows were introduced since the sum of upstream boundary flows is equal to the lower boundary flow with only a lag in time (see Fig. 3) and the outflow is much less than the sum of the Mississippi River and Old River flows.

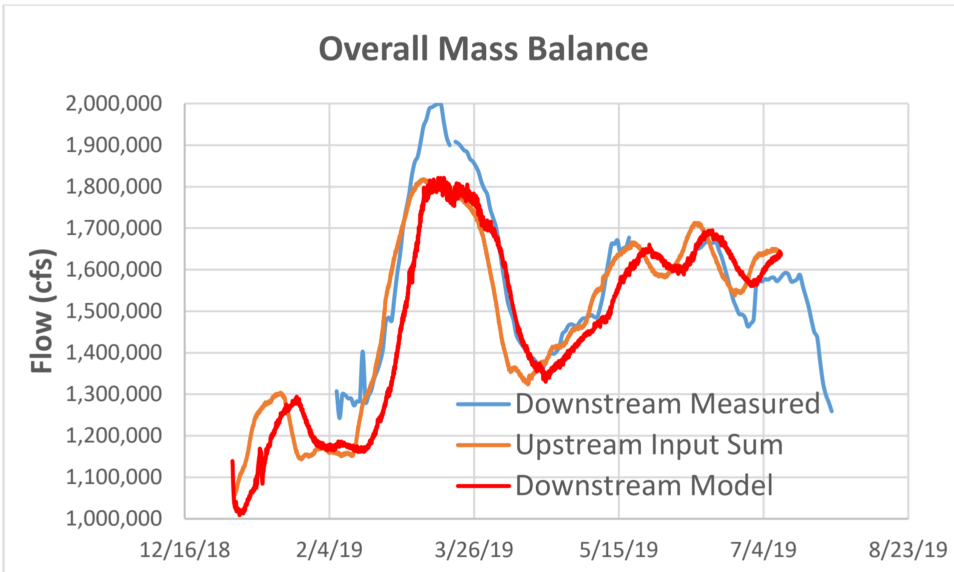

Figure 3 Downstream boundary flow comparison with inflows.

The report also includes a figure developed with a two-dimensional flow model but provides no details of the domain or flow conditions existing for the figure. The report itself points out that flows in the primary region of interest have momentum in multiple directions and not in a single direction as mathematically calculated in the HEC-RAS 1-D model used for the report. The single momentum direction assumed by the HEC-RAS model will result in errors in this part of the domain.

Like the Mississippi River boundary flow, the Yazoo River inflow boundary location does not have a flow gage reported. Examining the effects of the stage at the upper Yazoo River boundary shows that the inflow produces a higher stage at the upper boundary than the gage (Fig. 4) and suggests the inflow may be higher than measured. This conclusion is speculative since at the upstream boundary there has been little opportunity for the model to respond to the inflow. Model results, with and without pumping, are nearly identical this far upstream.

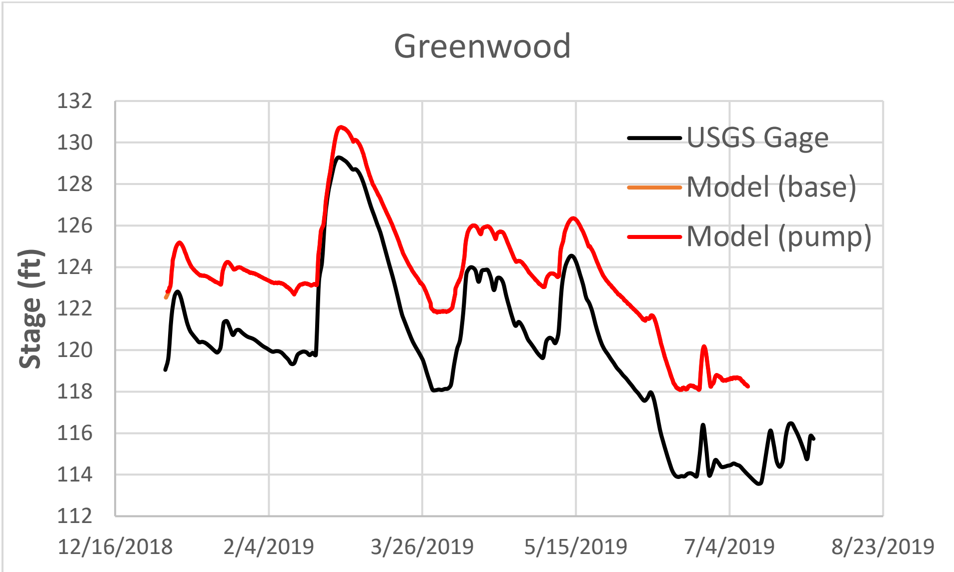

Figure 4 Stage comparison at Greenwood, model with and without pump nearly identical.

Stages farther downstream may be more indicative of Yazoo River model efficacy and are covered in a section below.

General Model Analysis

The HEC-RAS model and data provided with the report indicate it was simulated using version 5.0.3 of the software. Newer software versions have progressively added internal checks to check the network for errors. Using the latest version of HEC-RAS, the model throws 2 fatal errors (Fig. 5) preventing it from running the simulation. Both errors involved improperly specified lateral weir structures where two weirs overlapped each other. Clearly, if used in a calculation, this would double count water that would flow over each weir. In this case, the amount of overflow in these areas is so great that the magnitude of the errors would not overwhelm the results, but that would not always be the case in every model. Fixing these errors required little effort; but quite a bit of judgement was employed since no digital elevation map (DEM) or other topographic data were supplied. There are also errors and warnings that the software identifies that are not fatal to simulation. The latest version of HEC-RAS identified over 285 such errors, mostly on the Yazoo River reaches (see Fig. 6). It was not feasible for all these to be investigated and repaired since topographic and bathymetric data were not supplied.

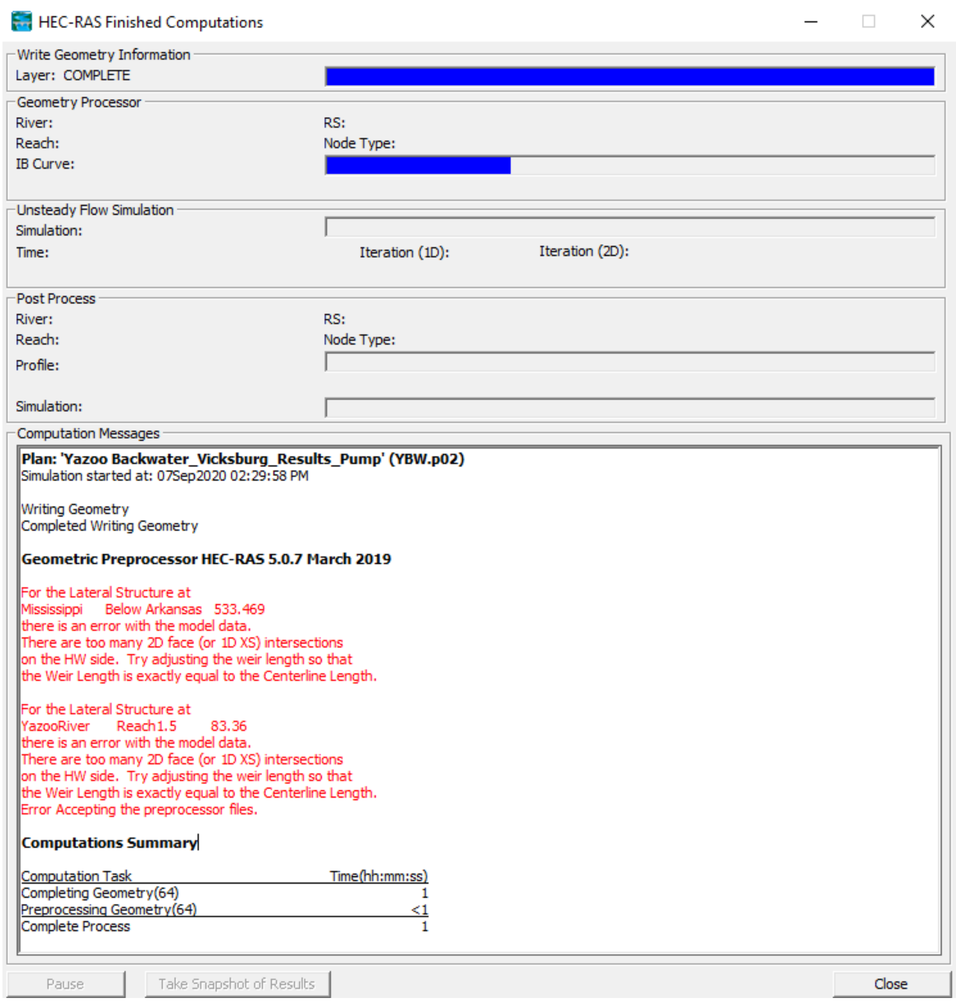

Figure 5 Errors preventing simulation of the model with the latest version, 5.0.7.

An example of the overlapping cross-sections occurred on the Mississippi River approximately 75 river miles above Vicksburg (see Fig. 7). While this type of error could cause serious issues with a model, in this case the levees involved were not overtopped so no change results from properly specifying the levees.

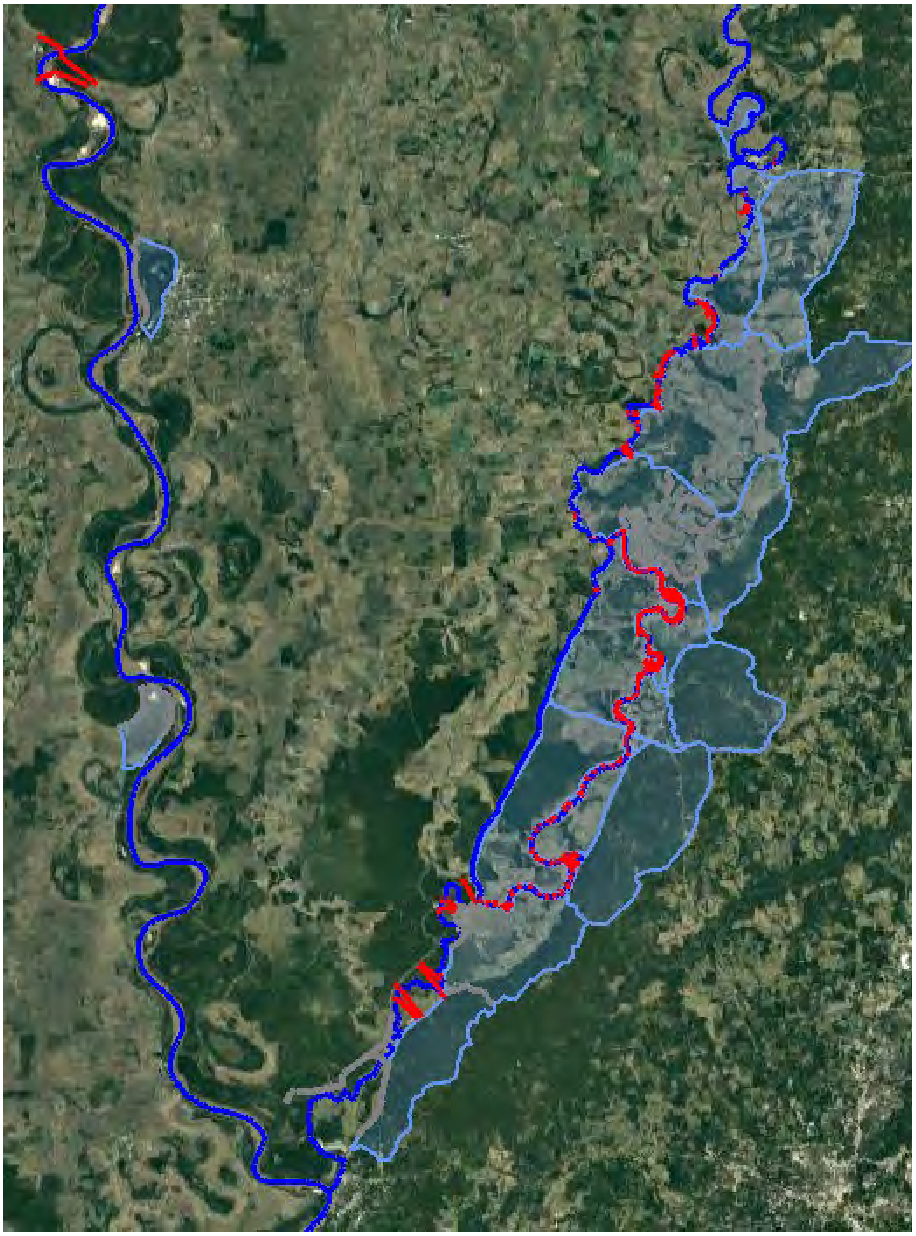

Figure 6 The over 285 errors and warnings identified in red by HEC-RAS version 5.0.7.

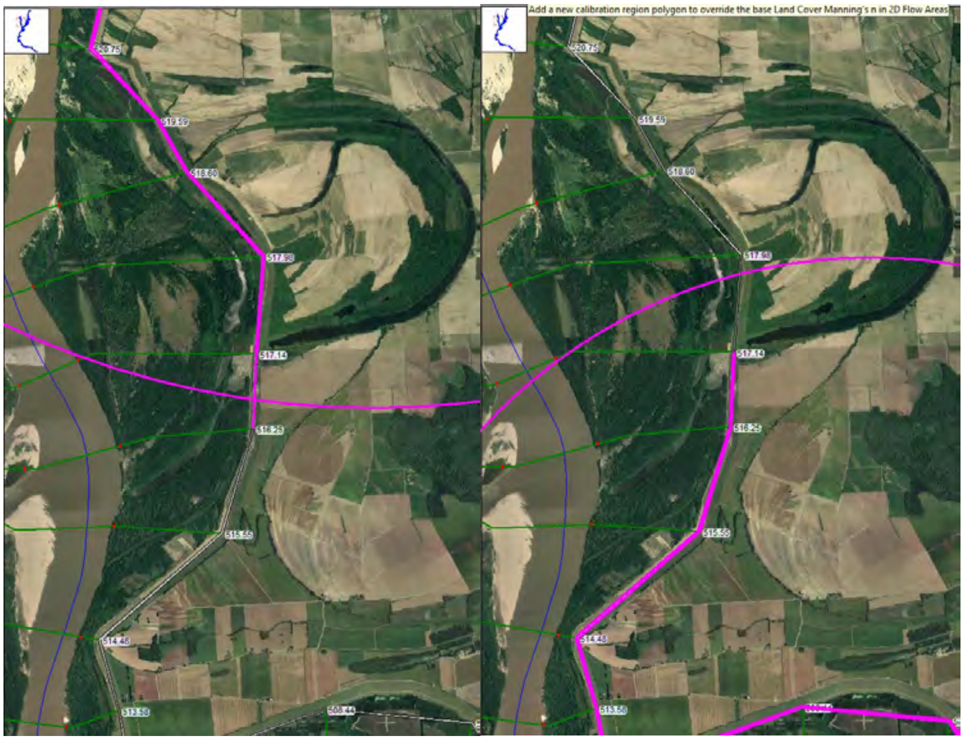

Figure 7 Overlapping weir error above Vicksburg.

Mississippi River Network

The network on the Mississippi River does a good job of representing the river. Most of the minor errors may well result from changes in projection of the grid or underlying topography. Version 5.0.7 does find 2 cross-section errors on the upper portion of the river reach (see Fig. 8). Both cross-sections (in red) are user entered, not interpolated, and the errors are minor. Being user entered means they were an error associated with data input into the model by the user, rather than caused by errors associated with cross-sections being interpolated by the software from two consecutive user specified cross-sections. All the cross-sections on the Mississippi River network of the model are listed as user defined and none interpolated. For the Yazoo River, many of the cross-sections are interpolated.

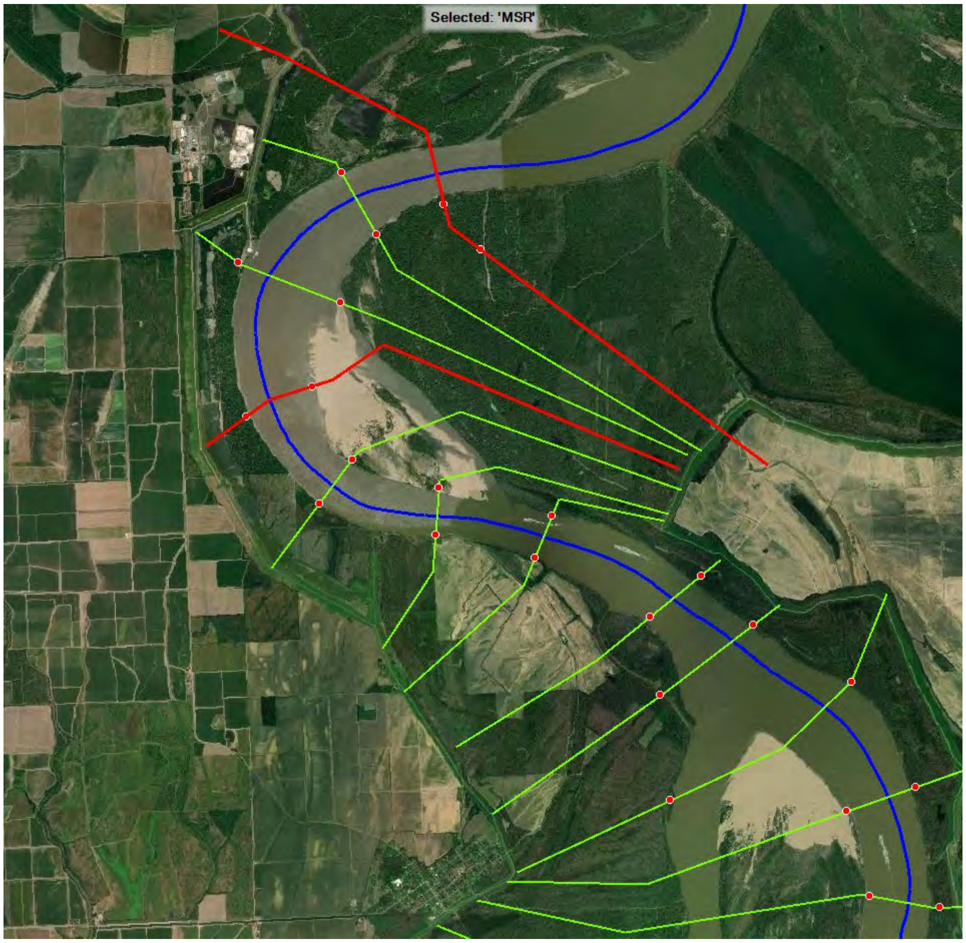

Figure 8 Two cross-section errors on upper Mississippi River network.

Mississippi River Results

As discussed above, the boundary flows were not sufficient to match the 2019 event. Gage locations between the upstream and downstream boundaries are limited to Vicksburg and Natchez. The USGS gage, 07289000, is nearly 100,000 cfs higher than the 2 modeled flows due to the boundary flows adding to less that the Vicksburg flow. The DCP-REV flow provided by the Corps in the DSS file is even less than the 2 modeled flows (see Fig. 9). Stage values are listed as reported on the Vicksburg gage but were not available for the 2019 period of interest.

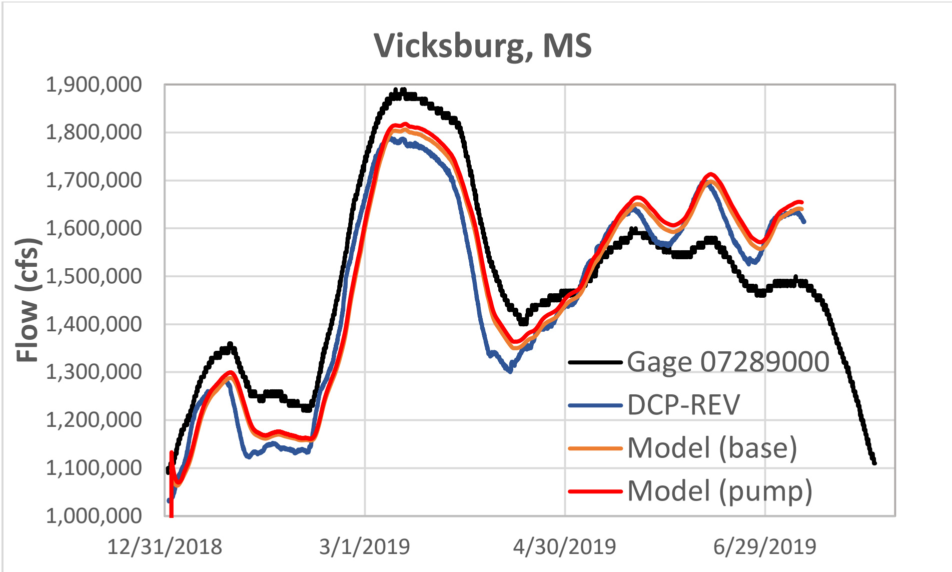

Figure 9 Measured and modeled flow rates at Vicksburg.

The gage at Natchez only reports stage data. The modeled data both with and without the pump are identical except for minor differences at the beginning of the simulation (see Fig. 10). The reported gage values are often 2 feet higher than the modeled values. The error significantly violates the stated 0.5 ft tolerance of Corps models.

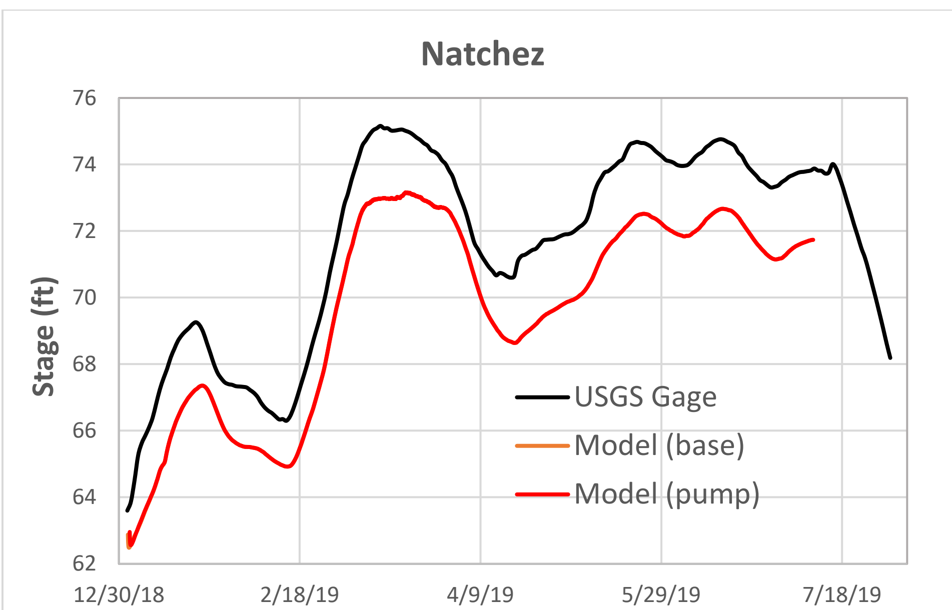

Figure 10 Gage and modeled data at Natchez.

As shown in the Boundary Condition section above (Fig. 2 & 3), neither the stage nor the flows of the model match the measured gage readings at the lower boundary of the model. The flow error results from both the inflow boundary differences as well as the lack of lateral inflows along the river. It cannot be explained why the stage input values differed so greatly form the reported gage values (Fig. 2).

Yazoo River Network

The Yazoo River network development has not received the same amount of attention as the Mississippi River. The network poorly represents the river channel and most of the cross-sections are interpreted from widely spaced, user-specified cross-sections (see Fig. 11). Except for the lower 22 miles of the Yazoo River, most of the other specified cross-sections are in the proximity of bridges.

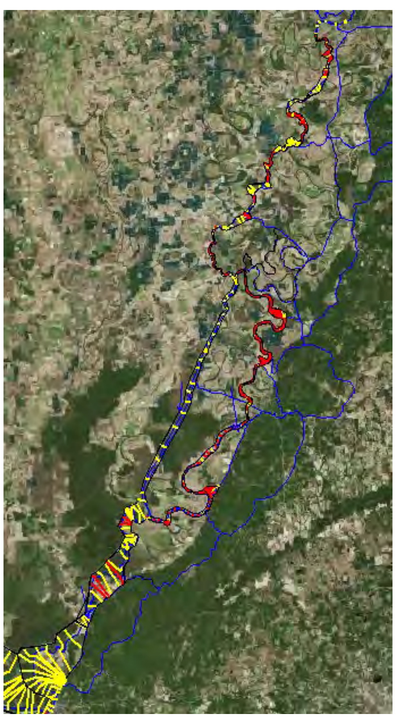

Figure 11 Yazoo River user-specified cross sections in yellow, interpolated cross-sections in red.

At the upstream boundary on the Yazoo River at Greenwood, the cross-sections improperly represent the length of bank-to-bank flow. The flow in Figure 12 is from right to left. Notice that these 4 cross-sections are not identified in the 285 cross-section errors and all four are user-specified. The red dots on the lines represent bank locations at a typical flow and stage, with the red lines representing bank lines. The yellow lines are the levees which I downloaded from the National Levee Database. All four cross sections are represented much wider than from levee to levee. In this case, the bank widths are underestimated.

Figure 12 Four cross-sections at upstream boundary of Yazoo River, location shown by circle.

For the upstream cross-section, from the left levee (bottom) to the right-most levee measures about 879 ft while the cross-section in the model is over 1232 ft long (Fig. 3). The vertical red line in Figure 13 is where the right levee would be located. The next downstream cross-section is identical, which is a common practice in modeling around bridges, but is shorter and the right levee is represented by the dashed red line in Figure 13. The bridge is not explicitly represented in the model. That they have represented the cross-sections and bank-lines turning right from cross-section 2 to 3 up and onto the bank is careless, but not necessarily mathematically harmful. The solution follows the numbers and they have a reasonable distance specified between the cross-sections.

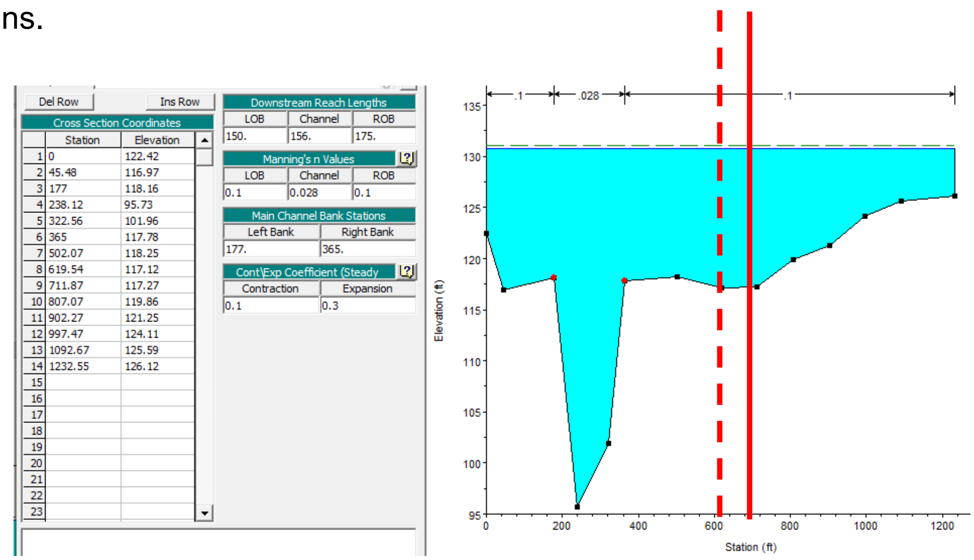

Figure 13 Two upstream cross-sections on the Yazoo River reach (167.58 & 167.55). Solid and dashed red lines represent the location of the right bank levees, respectively.

The lengths of the 3rd and 4th cross-sections are represented even longer than the first two cross-sections, but with the bank stations depicted on the right bank there is little information to determine errors in them. The pair of blue lines in Figure 14 represent the location of the channel line shown in Figure 12 and the red solid and dashed lines represent the right bank levee locations of the 3rd and 4th cross-sections, respectively. The errors associated with the first 4 cross-sections represent water conveyance greater than the actual cross-sections could produce. Any effort to correct these errors, and others, would require good bathymetry and topography of the Yazoo system. Either better information is not available, or it was applied very poorly. Since these cross-sections are upstream and downstream of a road bridge, better information should be available.

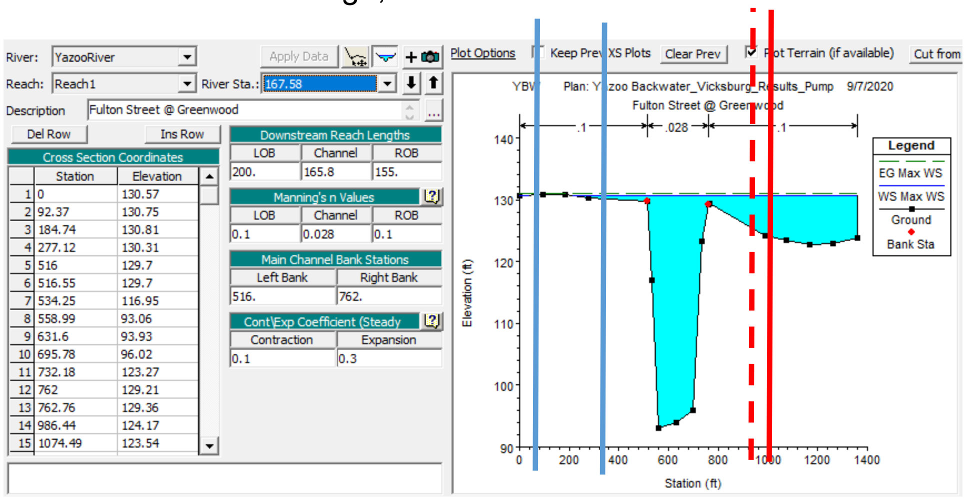

Figure 14 Third and 4th upstream cross-sections on the Yazoo River reach. Solid and dashed red lines represent the location of the right bank levee. Blue lines represent bank flow location.

At the next bridge downstream, 155.36, Roebuck Rd cross-sections are very poorly defined with bank stations over 800 ft apart when the channel measures less than 300 ft wide (Fig. 15 & 16). These cross-sections are physically entered into the software and then used to interpret other cross-sections which will also have excessive conveyance capacity.

Figure 15 Roebuck Road cross section showing channel over capacity, location shown by circle.

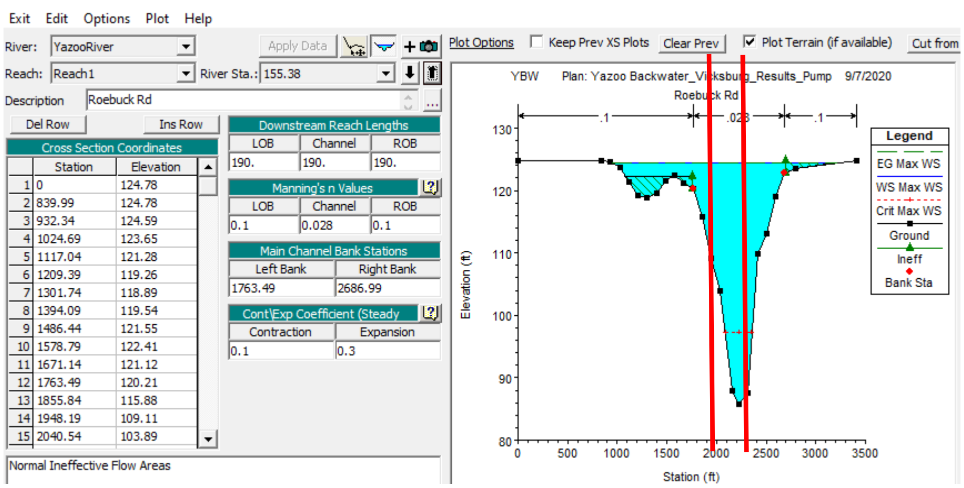

Figure 16 Roebuck Road cross-section showing apparent bank locations in red.

Farther downstream at Belzoni, 116.94, the same type of excess conveyance is depicted with over 600 ft of channel from bank to bank at a roughness of 0.028 while it measures just a little over 300 ft (Fig. 17).

Figure 17 Bridge cross-sections at Belzoni demonstrate the same excess conveyance, location shown by circle.

Bridges at Highway 49, Satartia, Highway 61 (which is also incorrectly located at the old bridge) show similar situation where the main channel conveyance with a reasonably low roughness coefficient is wider than realistic. All these are used to interpolate cross sections that will produce higher conveyance than reality.

One of the user specified cross-sections in the lower Yazoo River, 1.32, is shown in Figures 18 & 19. Near the confluence of the Yazoo with the Mississippi is depicted as being over 2000 ft from bank to bank but does at least have a higher roughness coefficient. The cross-sections above and below are much more realistic.

Figure 18 Cross-section 1.32 just upstream of confluence with MS River, location shown by circle.

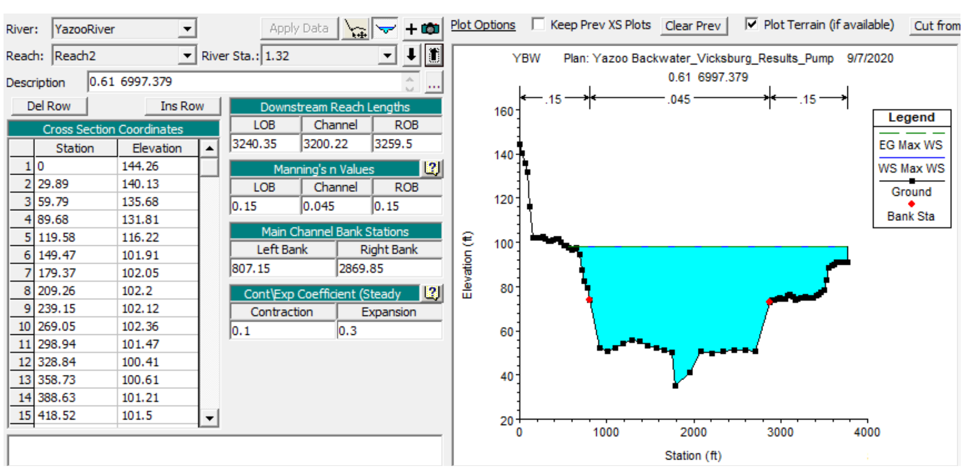

Figure 19 Cross-section 1.32 just upstream of confluence with MS River.

Yazoo River Results

As shown in Figure 4, the stage predicted by the model at the upstream boundary, river mile 167.64, on the Yazoo River is 2-4 ft higher than the reported gage values. As noted, since the model needs to respond to the initial flow input, this information could be misleading.

Downstream at river mile 151.11, Shell Bluff, the model still predicts stages 4 ft higher for lower stages, but the predictions lessen to 1+ ft at higher stages (see Fig. 20). The difference in model results with and without the pump are too small to notice at the scale of the graph and after startup vary by only hundredths of a foot.

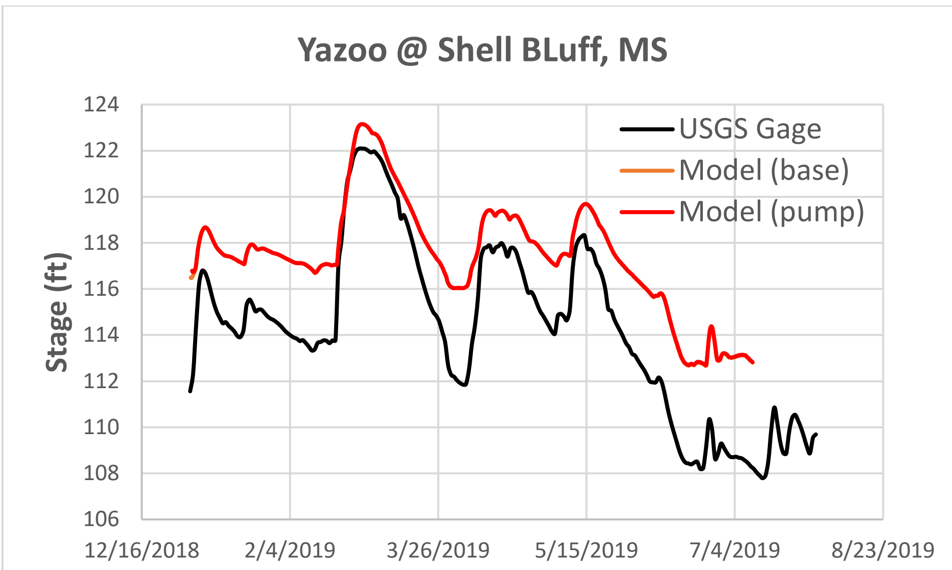

Figure 20 Model and gage stage comparison at Shell Bluff.

Approximately 35 miles downstream at Belzoni (river mile 116.93), gage and model results have reversed position and now gage values are substantially higher than the model predictions. At Belzoni the peak gage value is over 5 ft higher than the model predicts (see Fig. 21). After startup the difference between model simulations with and without the pump is still only hundredths of a foot at higher stages and tenths of a foot at lower stages.

Another 30+ miles downstream at Yazoo City (river mile 83.38) reported gage values are still 2.5 ft higher than model results for the higher stages with varying differences for lower stages (Fig. 22). Model results with and without the pump vary by a tenth of a foot for higher stages and 2-3 tenths of a foot for lower stages. For part of the simulation the model predictions fail to follow the trend in stage changes.

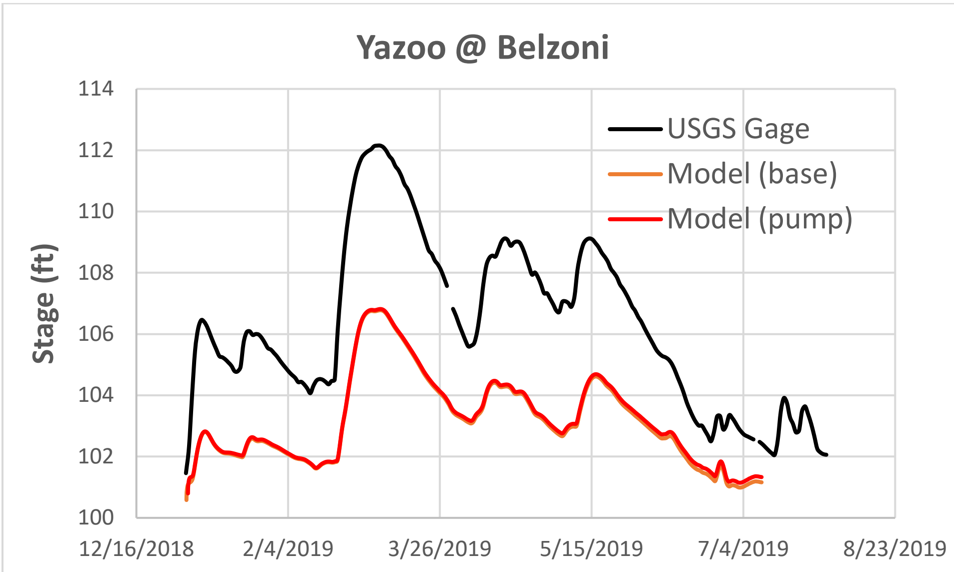

Figure 21 Model and gage comparison at Belzoni.

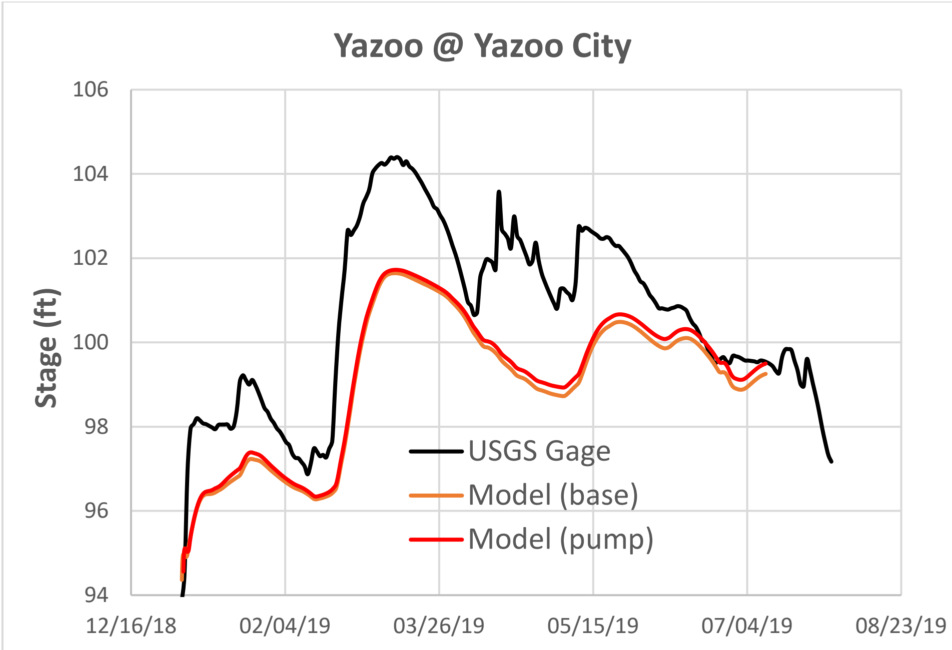

Figure 22 Model and gage comparison at Yazoo City.

At Satartia (river mile 53.88), nearly another 30 miles downstream, the reported gage values are generally 1 ft or less higher than the model on rising stages and slightly lower on the falling stage limb. The model with the pump is generally 0.25 ft higher stage than without pumping.

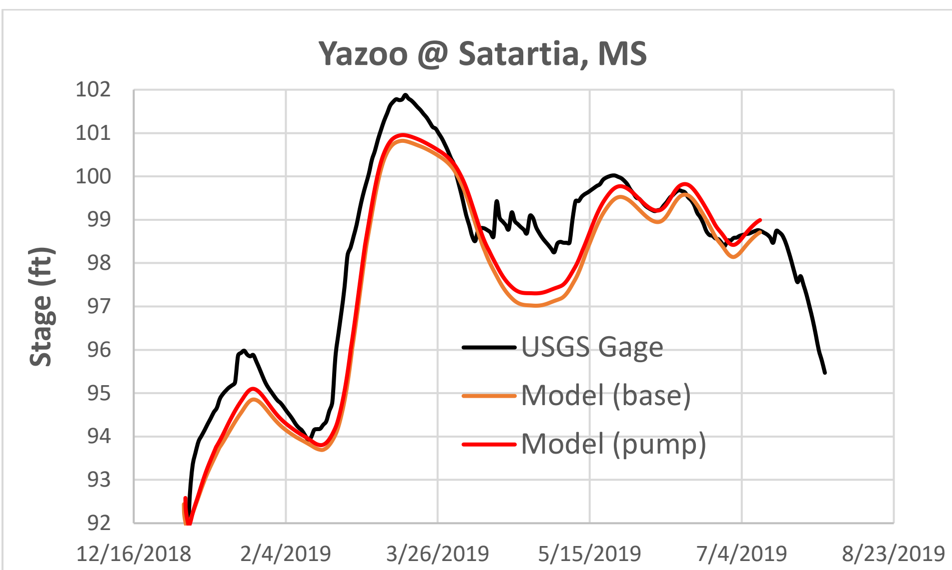

Figure 23 Model and gage comparison at Satartia.

Yazoo at Redwood is another 35+ miles below Satartia at river mile 17.43 and is the first to have flow data. Here the model does a much better job at matching the stage but does miss some of the trends of the measured flow gage values (see Fig. 24 & 25). While some of the flow errors could be associated with the incorrect inflow boundary condition on one or both rivers, missing changes in flow trends makes the stage data less credible (Fig. 25). Model results on the base case are up to 0.42 ft higher than without the pump, while the daily average stage exceeds the 0.5 ft tolerance 57 of 177 days. The median flow difference predicted by the Model with and without pumping is -80 cfs (Pump – Base). With the maximum difference after startup of -1333 cfs. This occurs because higher stages downstream will retard upstream flow.

The Redwood location is ~6 miles upstream of the pump location and the flow rates here, as well as the stage, would most certainly be affected by the pumping. The model is clearly not applying the flow rates adequately, which would have a resultant effect on the stages. Higher flow rates on the Yazoo River needed to match the 2019 event which will result in higher stages with and without the Backwater pumps.

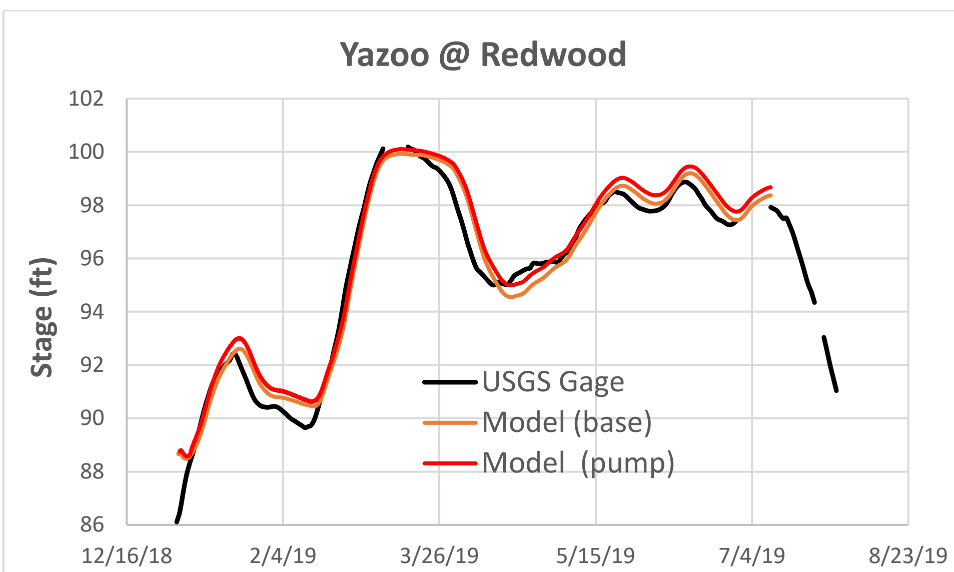

Figure 24 Model and gage comparison at Redwood.

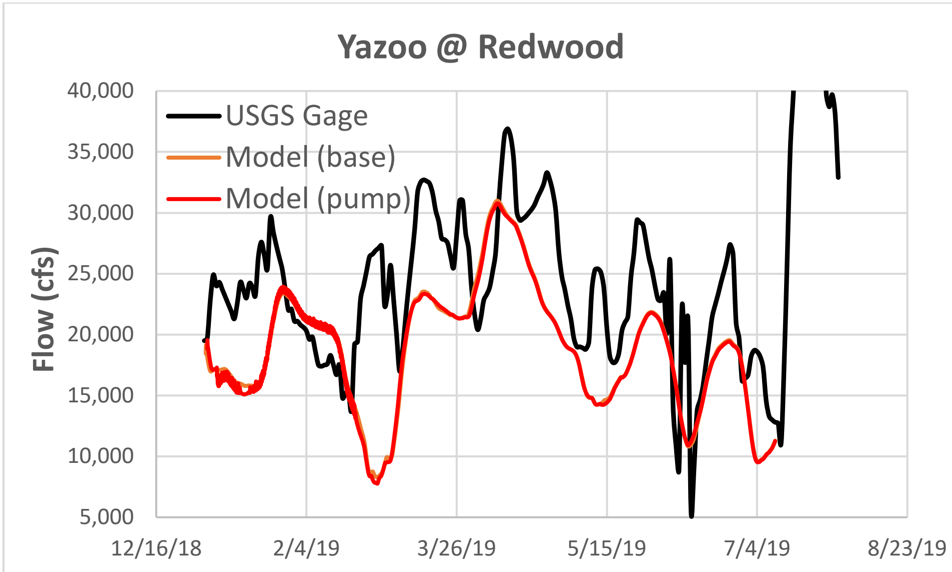

Figure 25 Flow comparison between model and gage at Redwood.

On the river side of the Steele Bayou Control Structure the models generally overpredict the stage versus the gage values by more than 1 ft. The modeled peak stage matches the gage reasonably well, but the peak is broader by over 24 hours. The land side of the Steele Bayou Control Structure is not explicitly modeled so no model data are available.

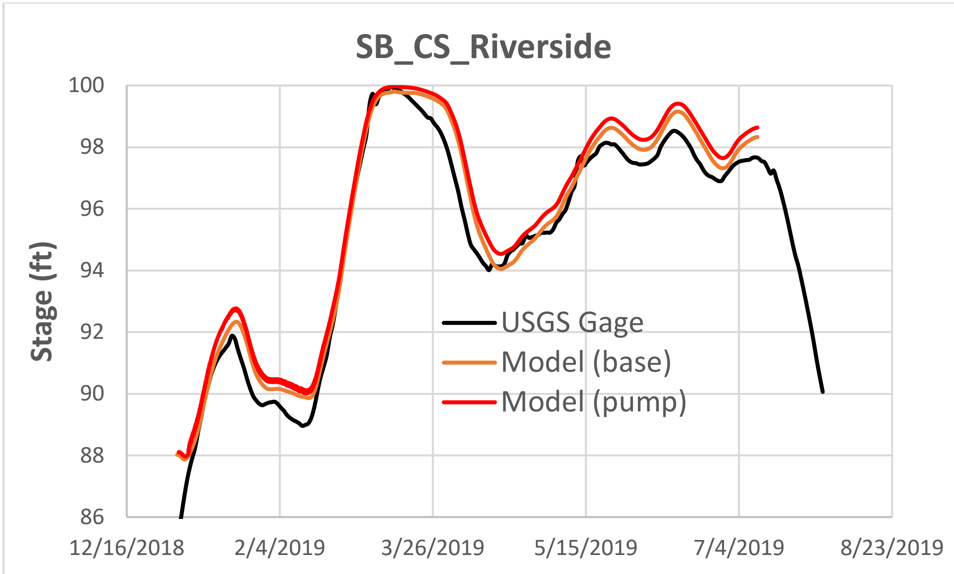

Figure 26 Model and gage comparison on riverside of the Steele Bayou Control Structure.

The Yazoo River gage below the Steele Bayou Control Structure is located just less than 1.5 river miles below the structure but the gage data do not cover the entire peak of the flow in 2019. The rising limb of the gage precedes the model predictions and is approximately 0.9 ft higher than either modeled prediction.

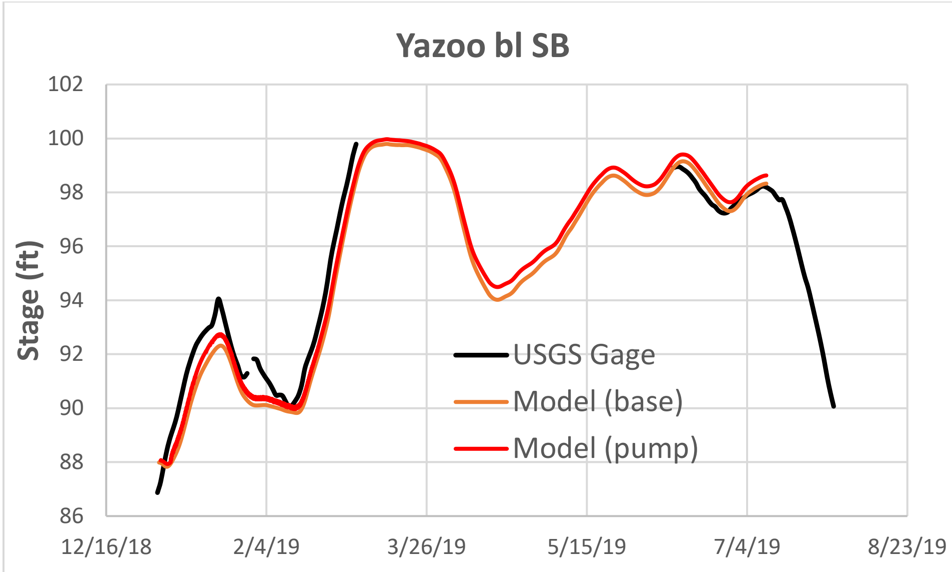

Figure 27 Model and gage comparison below Steele Bayou.

Once again, both model predictions fail to fully follow even the trend of the gage data. The failure is particularly apparent during the last 2 weeks of February where the gage measured a small peak of flow increase while both model predictions show a decrease in flows and the lowest flows this simulation. At this location, the flow differences with and without the pump show a nearly 14,000 cfs difference showing that most of the pumped flow continues downstream. It is not clear that this would be the case if the stage at the confluence of the Yazoo with the Mississippi were not so low.

It is unclear why the model developer chose to increase the bank-to-bank roughness coefficient from 0.028 to 0.045 starting in the last 40 river miles of the Yazoo River. Perhaps the increase was to account for some of the additional over-bank distance that the model seems to define. That type of an increase is more common in older steady-state flow models and not normally used in unsteady flow models where lower flows also need to be considered. The cross-section network also ceases using ineffective flow areas while about halfway through the last reach.

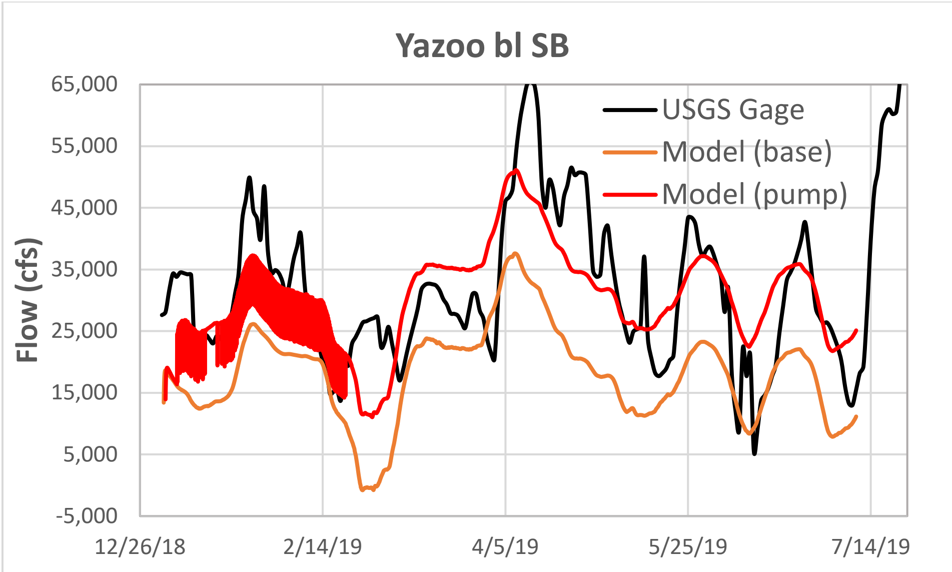

Figure 28 Flow comparison of between model and gage below Steele Bayou.

Conclusions

The inability of the model to match any of the 2019 stage gages at Vicksburg and Natchez demonstrates that the model is not sufficiently calibrated and that the inflow boundary conditions are not appropriate for the use.

The stage variations on the Yazoo River where consecutive gage locations change from the model being too low to being too high suggest network issues. This occurred between Shell Bluff (151.11 river mile) and Belzoni (116.93 river mile) in the upper reach of the Yazoo River network Figures 20 & 21). Examination of the upper Yazoo River reach shows a significant drop in water level between these two locations that would normally be indicative of a structure (Figure 29). It clearly shows the surface drop between the two data sites. Cross-section 134.71 (Fig. 30) was found to have an improper left bank station specified, which caused 7 consecutive cross-sections to be incorrectly interpreted with nearly 50% of each cross-section having a roughness coefficient of 0.10 rather than 0.028 (Fig. 31). Many other cross-sections have been interpreted on the Yazoo River and could suffer from similar issues.

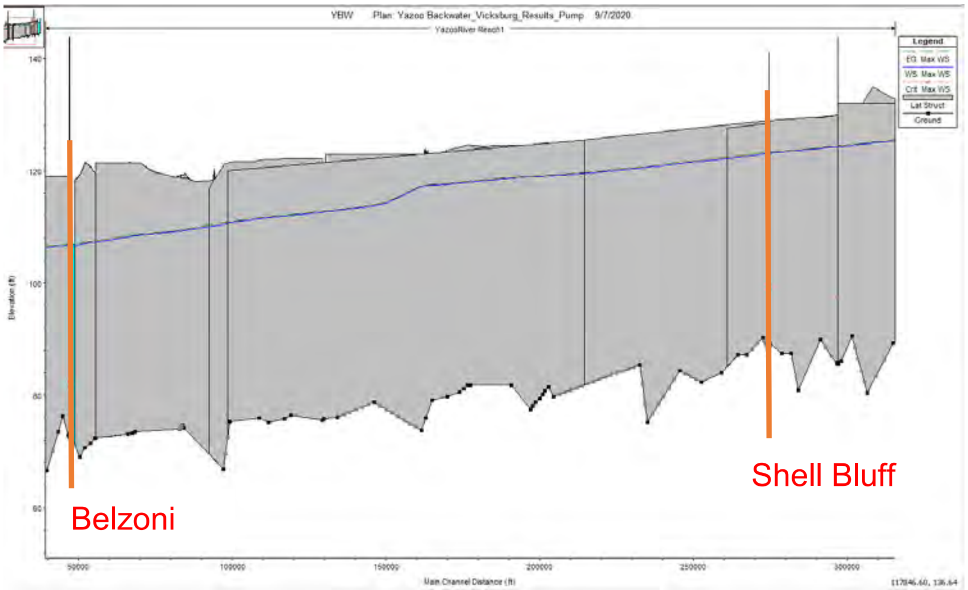

Figure 29 Water surface drop between Shell Bluff and Belzoni.

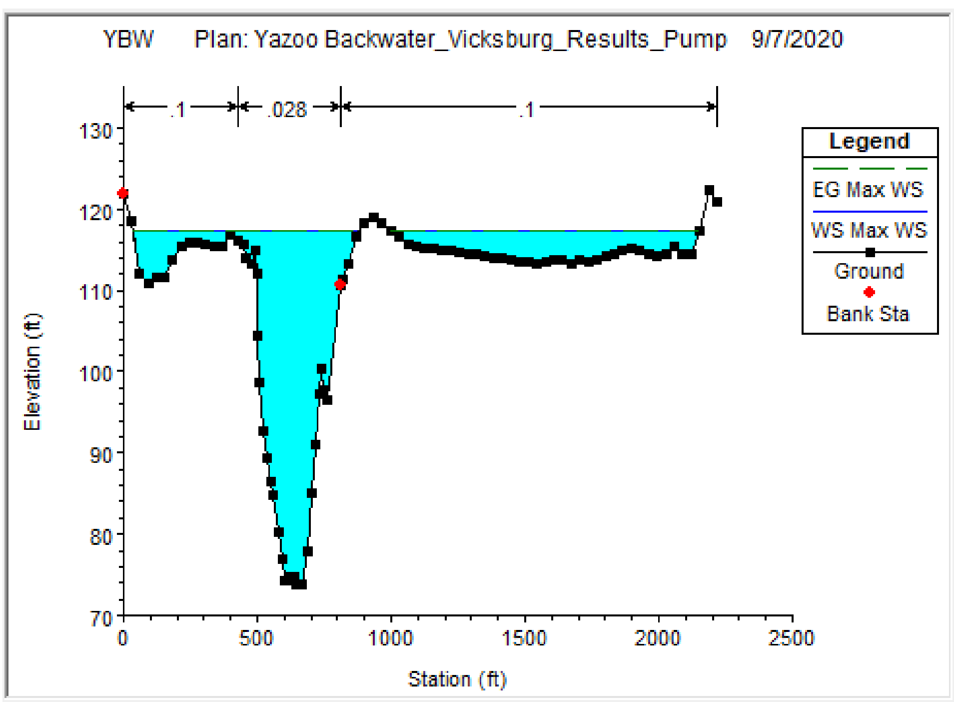

Figure 30 Cross-section 134.71 with the erroneous left bank station.

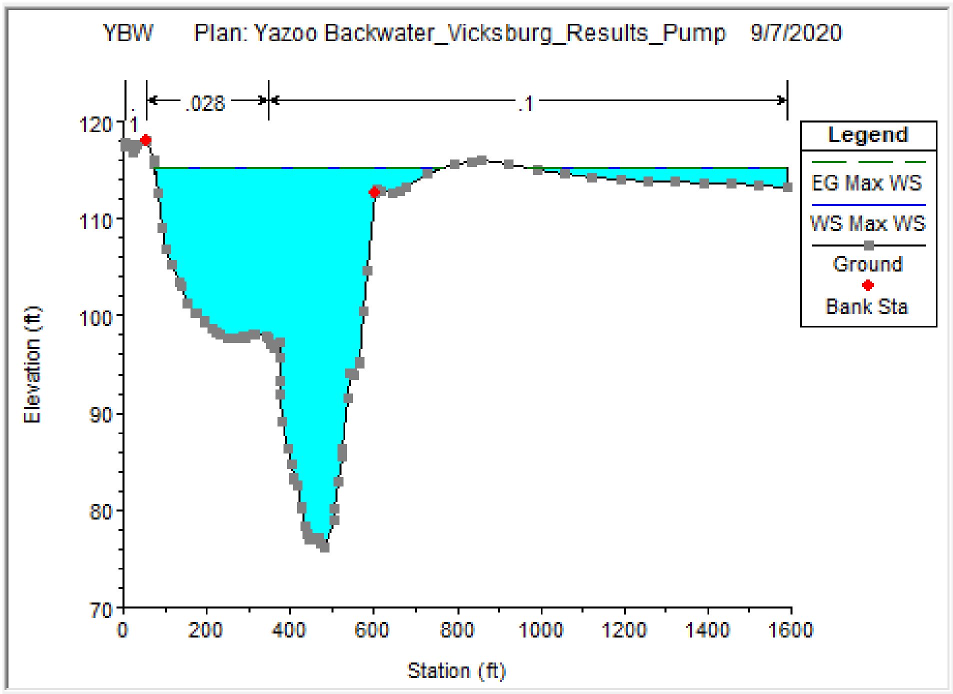

Figure 31 Cross-section 133.41* showing high roughness covering most of the main channel due to interpolation.

The other revelation from the results analysis is that the distances between many cross-sections on the Yazoo River exceed the actual measured distances. In an HEC 1D model the river stations (cross-sections) are labeled incrementally starting from the most downstream point, moving upstream. Although the numbers just need to be increasing upstream, it is common to label them with river-mile distances for clarity. Quick examination demonstrates that the river-mile labels of the cross-sections reasonably agree with the actual Yazoo River length. The sum of the distances between the cross-sections, which are used in model calculations, are longer than the actual river reaches. Overall, the 3 Yazoo River reaches extending to the upper Greenwood boundary have a mathematical-calculation length of 1,028,363 feet (194.76 miles) specified, while the actual length of these reaches is closer to the 167.64 river-miles designated by the Model cross-section labels. For calculation purposes that defines the river over 27 miles longer than the 3 Yazoo reaches measure. Most of that error occurs in the lower reach where the Backwater pumps would be located. I measured the lowest Yazoo River reach which extends from the confluence with the Mississippi River to the confluence with the W-WIT channel. It measures 46.5 miles while the Model is calculating over a length of 64 miles. The error significantly affects the volume and the timing of peak flows and stages along the reach of greatest interest.

The model requires extensive work to improve the Yazoo River network and the boundary conditions so it can be calibrated and then applied to the Backwater calculations during the 2019 event.

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EDUCATION:

2001	Ph.D. (Civil Engineering), University of California, Davis
1993	M.S. (Civil Engineering), University of California, Davis
1970	B.S. (Mechanical Engineering), Rose-Hulman Institute of Technology

POSITIONS:

2016 -	Consultant, Hydrodynamic and Water Quality
2009 - 2016	Professional Project Scientist, C&EE Dept., Univ. of California, Davis
2007- 2009	Professional Research Scientist, C&EE Dept., Univ. of California, Davis
2003- 2007	Professional Research Engineer, C&EE Dept., Univ. of California, Davis
2001- 2003	Postdoctoral Research Engineer, C&EE Dept., Univ. of California, Davis
1993- 2001	Postgraduate Research Engineer, C&EE Dept., Univ. of California, Davis

RECENT PUBLICATIONS:

Durand, John, Amber Manfree, Josue Medellin-Azuara, Fabian Bombardelli, William Fleenor, Yumiko Henneberry, Jon Herman, Carson Jeffres, Michelle Leinfelder-Miles, Robert Lusardi, Brett Milligan, Peter Moyle and Thomas Young, Drought and the Sacramento-San Joaquin Delta, 2012-2016: Synthesis Review and Lessons, Report to the Delta Stewardship Council, April 2018

Fleenor, William, Lily Tomkovic, Public Domain HEC-RAS Model with 2-D Floodplain of the Yolo Bypass and its Connection and Effects on the Sacramento River, Report to Yolo County (Contract 2014324), February 2017

Fleenor, William E., Sam Sandoval-Solis, Deanna Sereno, Laura Condon, and Josh H. Viers, Independent Peer Review of the Sacramento Water Allocation Model (SacWAM): Report to the Delta Science Program and the State Water Resources Control Board. Delta Stewardship Council, Sacramento, CA, December 2016.

Fleenor, William E., Peter Goodwin, Nancy Monsen, and Cathy Ruhl, On Estimating Net Delta Outflow (NDO): Approaches to Estimating NDO in the Sacramento-San Joaquin Delta, An Independent Peer Review for the Delta Science Program and the State Water Resources Control Board. Delta Stewardship Council, Sacramento, CA, September 2016.

Durand, John, William E. Fleenor, Richard McElreath, Maria J. Santos, and Peter Moyle, Physical Controls on the Distribution of the Submerged Aquatic Weed *Egeria Densa* in the Sacramento-San Joaquin Delta and Implications for Habitat Restoration, San Francisco Estuary and Watershed Journal, 2016.

Trowbridge, P.R., M. Deas, E. Ateljevich, E. Danner, J. Domagalski, C. Enright, W. Fleenor, C. Foe, M Guerin, D. Senn, and L. Thompson, Recommendation for a Modeling Framework to Answer Nutrient Management Questions in the Sacramento-San Joaquin Delta, Central Valley Regional Water Quality Control Board, 2016

Ayala, Ana I., Alicia Cortéz, William E. Fleenor and Francisco J. Rueda, *Seasonal scale modeling of river inflows in stratified reservoirs: structural vs. parametric uncertainty in inflow mixing*, Environmental Modeling and Software, June 2014.

Medellín-Azuara, J., R. Howitt, E. Hanak, J. Lund and Wm. Fleenor, "Agricultural Losses from Salinity in California's Sacramento-San Joaquin Delta", San Francisco Estuary and Watershed Journal, March 2014.

Cortéz, Alicia, William E. Fleenor, M. G. Wells, I. de Vicente, and F. J. Rueda, *Pathways of river water to the surface layers of stratified reservoirs*, Limnology and Oceanography, 2014.

Siegfried, Lucas J., William E. Fleenor and Jay R. Lund, *Physically Based Modeling of Delta Island Consumptive Use: Fabian Tract and Staten Island, California*, San Francisco Estuary and Watershed Journal, 2014.

Fleenor, William E. and Fabián Bombardelli, *Simplified 1-D Hydrodynamic Modeling of the Sacramento-San Joaquin Delta – Sea Level Rise and Water Diversion Effects*, San Francisco Estuary and Watershed Journal, December 2013.

Schaefer, Minta M., Laura A. Doyle, William E. Fleenor, and Michael L. Johnson, "Fate and Transport of Three Pharmaceuticals in the Sacramento–San Joaquin Delta", San Francisco Estuary and Watershed Journal, June 2013.

Medellín-Azuara, Josué, John Durand, William E. Fleenor, Ellen Hanak, Jay Lund, Peter Moyle, Caitrin Phillips, *Costs of Ecosystem Management Actions for the Sacramento-San Joaquin Delta*, Public Policy Institute of California, April 2013.

Hanak, Ellen, Jay Lund, John Durand, William E. Fleenor, Brian Gray, Josué Medellín-Azuara, Jeffrey Mount, Peter Moyle, Caitrin Phillips, and Barton "Buzz" Thompson, *Stress Relief: Prescriptions for a Healthier Delta Ecosystem*, Public Policy Institute of California, April 2013.

Nover, Daniel M., E. R. McKenzie, G. Joshi and Wm. E. Fleenor, "Assessment of Colloidal Silver Impregnated Ceramic Bricks for Small-Scale Drinking Water Treatment Applications", International Journal for Service Learning in Engineering, Humanitarian Engineering and Social Entrepreneurship (IJSLE), Spring 2013.

Mount, J., Wm. Bennett, J. Durand, Wm. Fleenor, E. Hanak, J. Lund and P. Moyle, *Aquatic Ecosystem Stressors in the Sacramento-San Joaquin Delta*, Public Policy Institute of California, June 2012, 24 pg.

Moyle, P., Wm. Bennett, J. Durand, Wm. Fleenor, E. Hanak, J. Lund and J. Mount, *Where the Wild Things Aren't – Making the Delta a Better Place for Native Species*, Public Policy Institute of California, June 2012, 55 pg.

Ogunyoku, Temitope Adebimpe, Daniel Nover, Erica McKenzie, Geetika Joshi and William E. Fleenor, *A Participatory Approach to Identifying Point-Of-Use Drinking Water Treatment Strategies in the Developing World*, International Journal for Service Learning in Engineering, May 2011, pp. 14-32

Moyle, P.B., W. A. Bennett, Wm. E. Fleenor and J. R. Lund, *Habitat Variability and Complexity in the Upper San Francisco Estuary*, 2010, SF Estuary Journal (2010).

Rigosi, A., William E. Fleenor and Francisco Rueda, *State of the art and recent progresses in phytoplankton succession modeling*, Environmental Reviews (2010)

Lund, J., E. Hanak, Wm. E. Fleenor, B. Bennett, R. Howitt, J. Mount, and P. Moyle, *Comparing Futures for the Sacramento-San Joaquin Delta*, 2010, 284 pg., UC Press, ISBN: 978-0-520-26197-6 (edited, expanded and updated from PPIC publication).

Monismith Stephen G., James L. Hench, Derek A. Fong, Nicholas J. Nidzieko, William E. Fleenor, Laura P. Doyle and S. Geoffrey Schladow, *Thermal Variability in a Tidal River*, ESTUARIES AND COASTS, vol 32, issue 1, pg 100-110 DOI: 10.1007/s12237-008-9109-9 Published: Jan 2009. (*recipient of the 2011 Pritchard Award, an award given every two years for the best Physical Oceanography paper*)

Lund, J., E. Hanak, Wm. E. Fleenor, R. Howitt, J. Mount, and P. Moyle, *Comparing Futures for the Sacramento-San Joaquin Delta*, Public Policy Institute of California, 2009, 241 pg.

Lund, J., Hanak, E., Fleenor, Wm., Bennett, W., Howitt, R., Mount, J., and P. Moyle, *Comparing Futures for the Sacramento-San Joaquin Delta*, Public Policy Institute of California, Appendix J, 2009.

Fleenor, Wm., Hanak, E., Lund, J., and J. Mount, *Delta Hydrodynamics and Water Salinity with Future Conditions*, Public Policy Institute of California, Appendix C, 2009.

Lund, J., Hanak, E., Fleenor, Wm., Bennett, W., Howitt, R., Mount, J., and P. Moyle, *Decision Analysis of Delta Strategies*, Public Policy Institute of California, Appendix J, 2009.

Behrens, D., Wm. E. Fleenor, J. DeGeorge and F. Bombardelli, "Instruction Manual for the Water Analysis Module (WAM)", Documentation of the hydrodynamic and water quality model used by the delta Risk Management Study and the Delta Solutions Program. 69 pg., Center for Watershed Sciences publication, 2009

Florsheim, J.L.; J. Mount; C. Hammersmark; Wm. E. Fleenor; and S.G. Schladow, *Geomorphic Influence on Flood Hazards in a Lowland Fluvial-Tidal Transitional Area, Central Valley, California,* Natural Hazards Review, Vol. 9, No. 3, August 1,2008. ASCE, ISSN 1527-6988/2008/3-116–124

Dietrich, J., D. Boylen, Wm. E. Fleenor, J. Groph, G. Hutchinson, J. Osborn, S. Strickland, D. Thompson, A. Van Gaest, T. Collier, M. Arkoosh and F Lodge, *Estimation of Hydrosystem Delayed Mortality Associated with Barge and In-River Outmigration Life-History Strategies of Snake River Spring/Summer Chinook Salmon*, 122 pg., Army Corp of Engineers, Walla Walla District, 2008

Lund, J., E. Hanak, Wm. E. Fleenor, R. Howitt, J. Mount, and P. Moyle, *Envisioning Futures for the Sacramento-San Joaquin Delta*, Public Policy Institute of California, 2007, 284 pg., ISBN: 98-1-58213-126-9.

Rueda, F.J., Wm. E. Fleenor, and I. de Vicente, *Pathways of river nutrients towards the euphotic zone in a deep-reservoir of small size: Uncertainty analysis*, *Ecological Modelling*, 202 (3), Apr 2007, pg.345-361.

Henson, S.S., D.S. Ahearn, R.A. Dahlgren, E. Van Nieuwenhuyse, K.W. Tate, and Wm. E. Fleenor, *Water Quality Response to a Pulsed-Flow Event on the Mokelumne River, California*, River Research and Applications, Vol. 23, 2007, pg 185-200.

Schladow, S. Geoffrey, Wm. E. Fleenor, Fabian A. Bombardelli, and Eu Gene Chung, "Quantifying sediment resuspension linkages to nutrient enrichment in the existing and future Salton Sea" (December 1, 2007). *University of California Water Resources Center. Technical Completion Reports*. Paper 998. http://repositories.cdlib.org/wrc/tcr/998

Hammersmark, C. T., Wm. E. Fleenor and S. G. Schladow**,** "Simulation of Flood Impact and Habitat Extent for a Tidal Freshwater Marsh Restoration". Ecological Engineering, Feb 2005, 905 pg 1-16

Fleenor, Wm. E**.**, and S. Geoffrey Schladow, "Mike 11 Numerical Modeling Study of the North Delta", in fulfillment of first supplement of CALFED grant #99-B193 EDL Data Report 2005-017, July 2005.

Fleenor, Wm. E., and S. Geoffrey Schladow, "Sediment Flux Variation in Two Central Valley Rivers", CALFED grant #99-B193 Report to CALFED Bay-Delta Authority, 2004.

Hammersmark, Chris, Fleenor, Wm. E., and S. Geoffrey Schladow, "Restoration Alternatives for McCormack-Williamson Tract", Report to CALFED Bay-Delta Authority and The Nature Conservancy, 2003.

Fleenor, Wm. E., and S. Geoffrey Schladow, "Lake Almanor – ICP-MS Investigation into Groundwater Budget", Report to Bechtel Engineering and PG&E, 2003.

Fleenor, Wm. E., and S. Geoffrey Schladow, "Lake Almanor – Acoustic Doppler Current Profiler Investigation of Flow Velocities near Outflow Tower", Report to Bechtel Engineering and PG&E, 2003.

Moughamian, Raffi, Wm. E. Fleenor, S. Geoffrey Schladow, "Tracer Study to Examine Bubbler Destratification - Pilot Study in a Closed-End Estuary", Report for HDR Engineering and the City of Stockton, 2003.

Fleenor, Wm. E., S. Geoffrey Schladow, "Lake Almanor – A Field Study into Outflow Mixing Problems", Report to Bechtel Engineering and PG&E, 2002

Bowersox, Randy, Fleenor, Wm. E., Schladow, S. Geoffrey, "Tracer Study of Hydrodynamic Mixing in a Closed-End Estuary", Report to HDR Engineering and the City of Stockton, 2001

Lund, J.R., Lawver, R.A., Anex, R.P., Tchobanoglous, G., Saska, L., Alaniz, V., Booher, C., Edgar, E., Fleenor, Wm. E., Freeman, W., Irving, K., Kear, T., Lindenauer, K., Wright, W. and Parker, J., "GIGO: A Spreadsheet Program for

Integrated Municipal Solid Waste Management, Version 1.0.” model documentation and software for public release, Department of Civil and Environmental Engineering, University of California, Davis, November, 1993.

Fleenor, Wm E., and Ian P. King, “Identifying Limitations on Use of the HELP Model”, *Landfill Closures - Environmental Protection and Land Recovery*, Edited by Dunn, Jeffrey R., and Udai P. Singh, A.S.C.E. Geotechnical Special Publication No. 53, 1995.

RECENT RESEARCH AND CONTRACTS:

Provide technical support to the Center for Watershed Sciences for a full Natural flow analysis for the State Water Resources Control Board 2019 -current.

Expert analysis and witness for the Natural Resources Defense Council for legal action on water quality issue (details currently confidential) 2019 -current.

Expert analysis and witness for Enterprise Council Group for legal action on flooding issue (details currently confidential) 2019 -current.

Provide technical expertise to support the State Water Resources Control Board efforts to develop and implement flow, water quality, and related requirements in the San Francisco Bay/Sacramento-San Juaquin Delta Estuary (Bay-Delta) watershed under contract agreement 17-101-300. 2019 - current.

Expert review of, and advice on, technical and regulatory documents for Delta Science Program, Delta Stewardship Council, 2017 – 2018

Evaluate whether performance measures of the “Delta Plan Performance Measures” are informative and based on best available scientific knowledge, Delta Stewardship Council 2017.

Provide expert general and local hydrodynamic knowledge to the External Science Panel for the 2016 Workshop: Role of Nutrients in Shifts in Phytoplankton Abundance and Species Composition in the Sacramento-San Joaquin Delta, Delta Stewardship Council, 2016

Lead author and independent science expert on Independent Peer Review of the Sacramento Water Allocation Model (SacWAM): Report to the Delta Science Program and the State Water Resources Control Board. Delta Stewardship Council, Sacramento, CA, 2016.

Lead author and independent science expert for Report on Delta Outflow Methods, a technical report to describe the data and methods underlying the estimates of Delta outflow and recommend a method for estimation net Delta outflow in real time on a daily time scale. Delta Stewardship Council, 2016

PI and project manager to review a 1D/2D combined hydrodynamic model for the Yolo Bypass by the California Department of Water Resources (DWR) and the Bureau of Reclamation (USBR) and to recreate the model with a public domain 1D/2D combined hydrodynamic model – HEC-RAS.

Project manager for the hydrodynamic modeling development of a new 3-D dimensional hydrodynamic and transport code using the UnTRIM solver. Coordination involves grid development work with the San Francisco Estuary Institute and code development with Resource Management Associates. Sub-projects include supervising a graduate student in the development of control structure code changes for the model and supervising a postdoc in the incorporation of the Deltares DELWAQ water quality and sediment transport model into the code. current

Co-PI and project manager of contract with Department of Water Resources and FEMA: Development of 2-D flow model recommendations for floodplain mapping. current

Project manager for the hydrodynamic modeling needs for the Delta Solutions Group of the Center for Watershed Sciences under the John Muir Institute of the Environment at UC Davis. Work includes the supervision of a postdoc and multiple graduate students (masters and PhD students) in 1-, 2- and 3-dimensional hydrodynamic and water quality modeling. Work has resulted in two books and multiple papers and expert advisory services for the state of California. Current sub-projects include supervising development of models for the Yolo Bypass, the Cache-Lindsay Slough region, the Suisun Marsh region and the Delta for 4 different graduate students, in addition to working with a 4th graduate student to investigate biological consequences of residence time. 2007- current

PI and project manager of contract with the California State Water Resources Control Board Contract 06-447-300, Task 20: Improvement in the Delta Island Consumptive Use (DICU) for the Sacramento-San Joaquin Delta. 2011- 2012

Co-PI of contract with the California State Water Resources Control Board Contract 06-447-300, Task 7: Delta hydrodynamic and water quality model development. 2010- 2011

PI and project manager of contract with the California State Water Resources Control Board Contract 06-447-300, Task 18: Predicting electrical conductivity in the South Delta using multivariate regression. 2010- 2011

Serve as expert supervisor for tracer injection in a lake in Spain to study the pathways of river water distribution in stratified reservoirs and to evaluate the influence that river-borne nutrients have on the nutrient dynamics of the surface layers of these systems and, hence, on their phytoplankton (focusing on the part of the community with the smallest cell size and the shortest response time to changes in environmental factors). Funding is through the Science Foundation of Spain. Collaborative study with the University of Granada, Granada, Spain 2009-2012.

Project manager for numerical modeling development for 3-D hydrodynamic and water quality analysis model. The model will be made available to the larger modeling community to investigate Delta issues, including sea level rise.

Funded by S. D. Bechtel, Jr. Foundation, and the David and Lucile Packard Foundation under contract through Watershed Sciences Center 2009-2010.

PI and project manager of modeling contract with DWR for examination of rehabilitation of McCormack-Williamson Tract for ecological and flood control benefits. Contract involves extending Mike 11 modeling work done under CALFED grant #99-B193 to include use of HEC-RAS model and incorporating the current NAVD88 vertical datum. 2007-2010.

Collaboration involving study of "In-Delta Recreation and Agricultural Economic Study", Results will bring to light the actual economic impact that a peripheral canal would impose on the Delta. Funded by S. D. Bechtel, Jr. Foundation, and the David and Lucile Packard Foundation under contract through Watershed Sciences Center 2009-2011.

Project manager for numerical modeling study of "Virtual Flooded Island Hydrodynamics and Ecological Assessment", Results will be development of guidelines for beneficial management of potential flooded Delta islands. Funded by S. D. Bechtel, Jr. Foundation, and the David and Lucile Packard Foundation under contract through Watershed Sciences Center 2008-2012.

Project manager for documentation and testing of the Water Analysis Module which was used extensively in Delta hydrodynamic and salinity analysis. Published work in report . Funded by S. D. Bechtel, Jr. Foundation, and the David and Lucile Packard Foundation under contract through Watershed Sciences Center 2008-2009.

Collaboration involving modeling study to support investigation of "Variability and Complexity in the Delta", Results will be development of guidelines for beneficial management of Delta habitat. Funded by State Water Resources Control Board, S. D. Bechtel, Jr. Foundation, and the David and Lucile Packard Foundation under contract through Watershed Sciences Center 2008-2009.

Project manager for ongoing remote data collection system on and around Lake Tahoe (http://remote.ucdavis.edu/tahoe_location.asp). Data are collected for the Tahoe Environmental Research Center (TERC) and used by a wide variety of UCD and off-campus agencies. The REMOTE system is done in coordination with other UCD departments. The work includes assisting other REMOTE units with data collection systems. 2001-current.

Coast to Mountain Environmental Transect project (COMET). A multidisciplinary project involving Bodega Bay Marine Lab, UC Davis and TERC in developing cyber-infrastructure to investigate how multiple environmental factors, in particular climate variability, impact ecosystems across a wide geographical transect that includes major ecosystems in California. Funding is being provided by the National Science Foundation ($2,100,000.00). 2006-2009

"Comparing Futures for the Sacramento-San Joaquin Delta". A project to examine the possible solutions to Delta water supply and quality determined from a previous contract. Perform hydraulic modeling to support the ecological, agricultural and economic analysis of the California water system. Funded by S. D. Bechtel, Jr. Foundation, and the David and Lucile Packard Foundation under contract through Watershed Sciences Center ($252,977.00). 2008-2009.

"Envisioning Futures for the Sacramento-San Joaquin Delta". Examined the hydraulic and ecological aspects of the Sacramento-San Joaquin Delta and determine viable solution possibilities for the California water system. Funded by a Public Policy Institute of California contract through Watershed Sciences Center. ($93,347.00). 2006-2007.

Co-PI and project manager of modeling contract with DWR through Reclamation District 348. Contract involves extending Mike 11 modeling work done under CALFED grant #99-B193 to include use of HEC-RAS model. 2005-2006.

Project manager for California Bay-Delta Authority grant ERP-02D-P51, Hydrodynamic and Oxygen Modeling of the Stockton Deep Water Ship Channel. Responsibilities include coordination with subcontractors (Stanford and USGS), planning and managing field work for use in calibrating and verifying the model, and attending and presenting at required CALFED group meetings. 2004-2006.

PAST ACADEMIC SERVICE:

Served as an expert reviewer of the Delta Plan for the benefit of the Associated Bay Area Governments, funded through the Delta Stewardship Council. Provided metrics by which the proposed Delta Plan could be judged to meet the objectives of the Delta Reform Act of 2009. June 2017

Served as lead author on a panel reviewing the SacWAM model for the State Water Resources Control Board. "Independent Peer Review of the Sacramento Water Allocation Model (SacWAM). December 2016

Served as an expert in hydrology and hydrodynamics to advise a panel of nutrient and phytoplankton experts for the State Water Resources Control Board, "Role of Nutrients in Shifts in Phytoplankton Abundance and Species composition in the Sacramento-San Joaquin Delta". November 2016

Served as chair and lead author for an independent peer review report for the Delta Stewardship Council. "On Estimating Net Delta Outflow (NDO): Approaches to Estimating NDO in the Sacramento-San Joaquin Delta". September 2016

Served on a review panel at the request of The Nature Conservancy and American Rivers to review a draft EIR/EIS, "Panel Review of the Draft Bay Delta Conservation Plan". August 2013

Served on invited expert panel representing the Delta Science Program to the California State Water quality Control Board in public hearing regarding the scientific and technical basis for considering potential changes to the 2006

Water Quality Control Plan for the San Francisco/Sacramento-San Joaquin Delta Estuary (Bay-Delta Plan) as part of the State Board's Phase II review for the Bay-Delta Plan, September 2012

Served on invited expert panel representing the Delta Science Program to the California State Water quality Control Board in public hearing regarding the scientific and technical basis for considering potential changes to the 2006 Water Quality Control Plan for the San Francisco/Sacramento-San Joaquin Delta Estuary (Bay-Delta Plan) as part of the State Board's Phase II review of the Bay-Delta Plan, February 2012

Chair of the Committee on Rules and Elections and the parliamentarian of the Academic Federation Executive Committee, 2011 – 2012

Taught graduate course, ECI289I, Hydrodynamics and Water Quality Modeling, spring quarter of 2011

Currently serving on the Committee on Rules and Elections in the Academic Federation, 2010- 2011

Served on invited expert panel representing the California State Water Quality Control Board in public hearing to determine flow regulations for the San Joaquin River, 2011

Served on invited expert panel of on behalf of the California State Water Quality Control Board for public hearings to determine environmental flow requirements for the Sacramento-San Joaquin Delta, 2010

Reviewed NSF proposal 1045286 for solicitation NSF 09-538, 2010

Reviewed (twice) the manuscript "Early Water Quality Modeling with Minimal Data to Support Management Decisions: A Case Study of Aguamilpa Reservoir", for the Journal of Water resources Planning and management, 2010

Vice-chair of the Committee on Research in the Academic Federation, 2007-2008

Taught Freshman Seminar class, spring 2010, in Appropriate Engineering Technology in Developing Communities (Biosand water filters)

Taught Freshman Seminar class, winter 2008, in Appropriate Engineering Technology in Developing Communities (fuel efficient wood-burning stoves)

Taught Freshman Seminar class, winter 2007, in Appropriate Engineering Technology in Developing Communities (sanitation - Sanitation Household Implementation Technologies)

Served on the review committee for the Ecosystem Restoration Program of the California

Bay-Delta Authority. Review of a numerical model of the San Joaquin River for which the Bay-Delta Authority had contracted. May 2006

Served on the Technical Selection Panel for the CALFED Science Program's 2006 Proposal Solicitation Package. November 2006

Taught Freshman Seminar class, winter 2006, in Appropriate Engineering Technology in Developing Communities (Drinking Water Quality for Health)

Reviewed the manuscript "Spatial and temporal scales of transport during the cooling phase of the ice-free period in a small high-mountain lake" for the journal *Aquatic Sciences*, May 2006

Reviewed draft report entitled "Flooded Islands Feasibility Report" for the Project Review Office for the California Bay-Delta Authority's Ecosystem Restoration Program, June 2006

Reviewed the manuscript "ADCP Measurements of Gravity Currents in the Chicago River, Illinois" for the *Journal of Hydraulic Engineering*, August 2006

Participated in development of curriculum for charter school established by Education Department in West Sacramento for socio-economically disadvantaged students to provide a college-track educational environment, 2006-2007

AWARDS, ACCOMPLISHMENTS & ASSOCIATIONS:

Recipient of the 2017 Career Achievement Award from the California Water and Environmental Modeling Forum
Recipient of the 2011 Pritchard Award, an award given every two years for the best Physical Oceanography paper
Founding Adviser, Engineers Without Borders – UCD, 2004 - current
American Society of Civil Engineers (ASCE)
Air and Waste Management Association (A&WMA)
American Geophysical Union (AGU)
American Water Resource Association (AWRA)
American Water Works Association (AWWA)
California Water and Environmental Modeling Forum
California EIT

RECENT COLLABORATORS (NON-UC DAVIS):
Laura Condon; University of Syracuse
Cliff Dahm; University of New Mexico; Albuquerque New Mexico
John DeGeorge; RMA Engineering; Fairfield, CA
Chris Enright; Delta Science Program; Sacramento, CA
Derek Fong; Stanford University; Palo Alto, CA
Peter Goodwin, University of Idaho
Maurice Hall; The Nature Conservancy; Sacramento, CA
Ellen Hanak; Public Policy Institute of California; SF, CA
Jim Hench; Stanford University; Palo Alto, CA

Bruce Herbold; EPA; San Francisco, CA
Chris Luecke; Utah State University; Logan, Utah
Stephen Monismith; Stanford University; Palo Alto, CA
Francisco Rueda; University of Granada, Spain
Sam Safram; San Francisco Estuary Institute, Berkeley, CA
Anthony Saracino; The Nature Conservancy; Sacramento, CA
Pete Smith; USGS; Sacramento, CA
Josh Veirs; University of California, Merced; Merced, CA
Leo Winternitz; The Nature Conservancy; Sacramento, CA
Wim Kimmerer, SFSU, San Francisco, CA
Amelia K. Ward, University of Alabama
Hans W. Paerl, University of North Carolina, Chapel Hill
Paul Harrison, University of British Columbia
Cathy Ruhl, USGS Water Science Center

PAST STUDENTS AND POSTDOCS:
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Randy Bowersox (M.S. 2002) Carlton Engineering, Grass Valley, CA
Amy Krich-Brinton (M.S. 2004) Larry Walker Associates, Davis, CA
Raffi Moughamian, (M.S. 2005) Central Contra Costa Sanitary District, CA
Jehan Sohoo Fugit (M.S. 2006) West-Yost Engineering, Davis CA
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Matthew Bates (M.S. 2010)
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David Corderi (Ph.D. 2010, Agriculture and Natural Resources Department)
Matthew Lim (M.S. 2011)
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Scott Greenwood (M.S. 2015)
Thomas Handley (M.S. 2016)

Laila Katsuri (M.S. 2016)
Jenny Ta (M.S. 2016)
Jeanette Newmiller (M.S. 2016)
Lily Tomkovic (M.S. 2016, Ph.D. expected 2019)

From: Eileen Shader <eshader@americanrivers.org>
Sent: Tuesday, August 27, 2024 6:06 PM
To: YazooBackwater MVK
Subject: [Non-DoD Source] Yazoo DEIS comments
Attachments: Yazoo DEIS AR Comments Final w Resilience plan.pdf

Mr. Renacker,
Please see attached for American Rivers' comments on the Yazoo Basin DEIS. Thank you for the opportunity to provide comments.

Sincerely,
Eileen Shader

Eileen Shader, CFM (she/her)
Senior Director, Floodplain Restoration
570-856-1128
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AMERICAN RIVERS
Life Depends on Rivers℠

AMERICAN RIVERS

August 27, 2024

Via email to YazooBackwater@usace.army.mil

Attention: CEMVK-PPMD
Vicksburg District, U.S. Army Corps of Engineers
4155 East Clay Street
Vicksburg, Mississippi, 39183

RE: Draft Environmental Impact Statement and Section 404(b)(1) for the Yazoo Basin, Yazoo Backwater, Mississippi, Project

Dear Mr. Mike Renacker:

On behalf of our more than 350,000 members and supporters, American Rivers is writing to express our opposition to Alternatives 2 and 3 in the Draft Environmental Impact Statement for the Yazoo Backwater Area Water Management Plan . We urge the U.S. Army Corps of Engineers (Corps) to permanently abandon efforts to build any variation of the environmentally destructive, dangerous Yazoo Backwater Pumping Plant. Instead of continuing to push for this agricultural drainage project, the Corps should support deployment of highly effective non-structural, natural, and nature-based flood risk reduction solutions as also requested by many local community leaders.

Since 1973, American Rivers has protected wild rivers, restored damaged rivers, and conserved clean water for people and nature. With headquarters in Washington, D.C. and 355,000 supporters, members, and volunteers across the country, we are the most trusted and influential national river conservation organization in the United States. As the nation's leading river advocate, American Rivers seeks to ensure our nation's rivers and floodplains are protected and restored.

American Rivers has a long history of engaging on proposals to address flooding in the Yazoo Backwater because proposed projects that include a pumping station have consistently been found to have immense impacts to the regions' rivers and wetlands, and the people and wildlife that depend on these critically important ecosystems. These concerns have resulted in the Yazoo Backwater rivers being named one of America's Most Endangered Rivers® eight times, most recently in 2024. While we appreciate the Corps' willingness to engage in constructive dialogue with our organization regarding the most recent preferred alternative, we remain gravely concerned that any alternative that includes a pumping station will significantly degrade the ecological functions of wetlands within the project area, and that pursuing a pumping plan of this capacity violates the 2008 Clean Water Act veto, setting a dangerous precedent for reversing decisions on highly impactful water resources projects. These impacts are all the more unacceptable in light of the nation's alarming increase in wetland losses[1] and the Supreme Court's 2023 decision in *Sackett v. Army Corps of Engineers* that has left millions of acres of wetlands without Clean Water Act protection. The concerns raised in our previous comment letters remain, including those submitted in response to the Notice of Intent on August 7, 2023[2]

American Rivers remains concerned that local community opposition to a preferred alternative that advances a pump focused solution has not been heard. For example, during the scoping comment period, 50 community members, homeowners, and landowners from Sharkey and Issaquena Counties submitted a letter in opposition to a pump station, and voiced their preference for a whole of government approach focused on non-structural and nature-based approaches.[3] Likewise, the Education, Economics, Environmental, Climate and Health Organization (EEECHO) advised the Corps the EEECHO opposes the USACE Preferred Alternative because it is "yet another appalling version of the dangerous Yazoo Pumps that will do nothing but reinforce...pervasive injustices."[4].

American Rivers calls on the U.S. Army Corps of Engineers (Corps) to respect the 2008 EPA veto of this project and end the effort to build a 25,000 cfs pumping station at Steele Bayou. This project is prohibited by the 2008 Clean Water Act § 404(c) Final Determination and should not be constructed. Recognizing the very real and serious flooding issues local communities face, the Corps should pursue Alternative 4, the Nonstructural Plan and should further explore opportunities to provide ongoing and sustainable benefits to the communities in the Yazoo Backwater Area while restoring this ecologically critical region.

1. Alternatives 2 and 3 Violate the Clean Water Act Veto

Alternatives 2 and 3 include construction of 25,000 cfs capacity pumping stations and water management plans in violation of the 2008 Clean Water Act veto. The Section 404(c) veto authority of the Clean Water Act[5] is an essential safeguard to ensure against excessive degradation of the nation's wetlands. Clean Water Act vetoes are extremely rare, with only fourteen ever issued, and is reserved for projects that will have unacceptable adverse impacts.

[1] Lang, M.W., Ingebritsen, J.C., Griffin, R.K. 2024. Status and Trends of Wetlands in the Conterminous United States 2009 to 2019. U.S. Department of the Interior; Fish and Wildlife Service, Washington, D.C. 43 pp.
[2] Comments from Conservation Organizations for the Notice of Intent to Prepare Draft Environmental Impact Statement for the Yazoo Backwater Area Water Management Project, 88 Fed. Reg. 43101. Submitted August 7, 2023.
[3] Letter from 50 community members, homeowners, and landowners from Sharkey and Issaquena Counties to Assistant Secretary of the Army (Civil Works) Michael Connor and Col. Christopher Klein, Vicksburg District Commander, August 4, 2023.
[4] Letter from Ruth Y. Story, EEECHO Executive Director to EPA Administrator Michael Regan and Assistant Secretary of the Army Michael Connor, May 30, 2023.
[5] 42 U.S.C. § 1344(c).

In 2008, the Environmental Protection Agency (EPA) exercised its authority under Section 404(c) and vetoed the Yazoo Pumps on the grounds that the project would destroy tens of thousands of acres of wetlands in the heart of the Mississippi River Flyway. The 2008 Clean Water Act veto prohibits "large-scale hydrologic alterations that would significantly degrade the critical ecological functions provided by at least 28,400 to 67,000 acres of wetlands in the Yazoo Backwater Area, including those functions that support wildlife and fisheries resources." [6] The veto also prohibits a range of plans, including a 14,000 cfs pumping plant operated at 91 feet, determining that "the subsequent operation of pumping stations would result in unacceptable adverse effects on fishery areas and wildlife."

The 2008 Clean Water Act veto explicitly prohibits a 14,000 cfs pumping plant with a pump-on elevation of 91-feet NGVD19[7] (the pumping regime for the 2007 Alternative 7).[8] Alternatives 2 and 3 appear to violate this prohibition as both include a 25,000 cfs pumping plant, which is 78% larger than the plant prohibited by the 2008 Clean Water Act veto. These pumps, of course, encompass a 14,000 cfs pumping capacity:

- Alternative 2 would operate a 25,000 cfs pumping plant with a pumps-on elevation at or below 90 feet for 7 months (214 days) each year during the designated crop season of March 16-October 15 and up to 93 feet during non-crop season of October 16-March 15.

- Alternative 3 would operate a 25,000 cfs pumping plant with a pumps-on elevation at or below 90 feet for 6 months and 21 days (205 total days) each year, during the designated crop season of March 25- October 15 and up to 93 feet during non-crop season of October 16- March 24.

Both alternatives would hold water levels below the prohibited 91-foot-NGVD elevation level for up to seven critical months each year during the designated crop seasons in an attempt to keep water levels from rising above 90-feet-NGVD. The DEIS shows that the pumps would be turned on when water levels are below 91 feet at least 82% of the time that they are used (18 out of the 22 times that the pumps would have been used over the period of record analyzed in the DEIS).

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[6] Final determination of the U.S. EPA's Assistant Administrator for Water pursuant to Section 404(c) of the Clean Water Act concerning the proposed Yazoo Backwater area pumps project, Issaquena county, Mississippi, signed August 31, 2008. https://www.epa.gov/sites/default/files/2015-05/documents/yazoo-final-determination_signed_8-31-08.pdf

[7] "Although not proposed to go forward, FSEIS Plans 3, 4, and 7, which also include a 14,000 cfs pumping station are expected to result in wetland impacts between approximately 28,400 and 118,400 acres (see FSEIS Main Report, Table 17, page 1-20). EPA has determined that each of these alternatives would also result in unacceptable adverse effects on fishery areas and wildlife." Clean Water Act 404(c) Final Determination at iii and 9.

[8] Alternative 7 included a 14,000-cfs pump station with a year-round pumping elevation of 91.0 feet, NGVD. 2007 FSEIS at SEIS-50; Yazoo Backwater Area Reformulation Main Report, October 2007 at 68.

The Clean Water Act veto prohibits a range of operating plans, including a 14,000 cfs pumping plant with a pump-on elevation of 91-feet NGVD. The veto documents the unacceptable adverse impacts of operating the proposed pumps "during the critical spawning and reading months" in early spring and summer.[9] "Spring flooding is the major factor responsible for fishery productivity within the Yazoo River Basin."[10] It is also critical to many bird species that depend on the Yazoo backwater area. EPA thus vetoed the proposed operating plans because they would have reduced "the extent and duration of the spring flood pulse [which] would severely reduce the current fish productivity of the lower Yazoo Basin."[11] That "reduction in the extent and duration of the spring flood pulse" would also "result in significant adverse impacts to those birds which not only utilize the Yazoo Basin, but are dependent upon backwater flooding during these periods."[12] EPA also documented how a decline in the spring flood pulse would have long-term effects throughout the year, explaining that " the scientific literature strongly suggests that bottomland hardwood forests shift over time to more drought tolerant/less flood tolerant species composition when backwater flooding is significantly reduced or eliminated. This shift is important because a change in plant community not only signals a change in hydrology, but also in the habitat resources available to wildlife."[13].

2. The DEIS Must Rigorously and Objectively Evaluate All Reasonable Alternatives

As stated in our August 7, 2023 comments on the Notice of Intent, the expedited process used to develop and select the Preferred Alternative and the limits the Army Corps imposed on its analysis of alternatives fails to meet the intent of these laws by selecting a Preferred Alternative:

(1) Without first ensuring that it is not prohibited by the 2008 Clean Water Act veto;
(2) Without first ensuring that it is the least environmentally damaging alternative, as required by the Clean Water Act.
(3) Without first ensuring that the significant adverse impacts to fish, wildlife, and aquatic resources are avoided, minimized, and mitigated, as required by the Water Resources Development Acts and the Clean Water Act.
(4) Without complying with the Federal Flood Risk Management Standard, which was enacted to ensure that federal agencies make sound flood risk and floodplain management decisions, including ensuring that federal flood mitigation projects will be resilient to floods that are larger than a 100-year flood event, and that nature-based alternatives are considered.
(5) Without documenting, through valid hydrologic modeling, that discharging 16 billion gallons of water a day into an already flooded Yazoo River will not increase flood risks for highly vulnerable downstream communities that continue to suffer from pervasive and systemic environmental injustices. The first downstream neighborhood at risk is the

[9] Final determination at 56
[10] *Id*.
[11] *Id.*
[12] *Id.* at 58.
[13] *Id*. at 52.

Ford Subdivision in North Vicksburg where 93% of residents are Black and 61% of households are low-income. The Ford Subdivision already floods on a regular basis.

(6) Without first assessing the project's environmental impacts as required by the National Environmental Policy Act.

The analysis of alternatives is the heart of the environmental review process. In developing a water resources project, the Army Corps must evaluate a range of reasonable alternatives—including nonstructural, natural, and nature-based solutions that alone or in combination would protect and restore the natural functions of the rivers, streams, and wetlands in the YBWA. The Corps must ultimately select an alternative that achieves these objectives while causing the least possible amount of harm to the environment. This process is necessary to comply with numerous environmental laws and agency guidance including:

- The National Environmental Policy Act, which requires that the DEIS rigorously explore and objectively evaluate "a reasonable range of alternatives that are technically and economically feasible and meet the purpose and need for the proposed action."[14] . Critically, the EIS is not to be used to justify a decision that has already been made.[15]
- The Clean Water Act 404(b)(1) Guidelines which prohibit the Corps from proceeding with a civil works project unless the Corps demonstrates that the project is the least environmentally damaging practicable alternative, which can only be done by examining a full range of reasonable alternatives. "An alternative is practicable if it is available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes."[16].
- Repeated direction from Congress via Water Resources Development Acts that directed the Army Corps to ensure that all water resources projects reflect national priorities by "protecting and restoring the functions of natural systems.", and to consider non-structural alternatives and practicable "natural and nature-based infrastructure alternatives." [17]
- The Council on Environmental Quality has made clear that "[r]easonable alternatives include those that are practical or feasible from a technical and economic standpoint and using common sense, rather than simply desirable from the standpoint of the applicant. Congress has long recognized the importance of the Corps carefully assessing wetland restoration, nonstructural measures and reasonable alternatives that are not within the agency's jurisdiction when evaluating alternatives.

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[14] 40 C.F.R. § 1508.1(z). The Council on Environmental Quality has long made it clear that "[r]easonable alternatives include those that are practical or feasible from a technical and economic standpoint and using common sense, rather than simply desirable from the standpoint of the applicant." Forty Most asked Questions Concerning CEQ's NEPA Regulations, 46 Fed. Reg. 18,026 (March 23, 1981).

[15] City of Bridgeton v. FAA, 212 F.3d 448, 458 (8th Cir. 2000) (quoting Citizens Against Burlington, Inc. v. Busey, 938 F.2d 190, 196 (D.C. Cir. 1991), cert. denied 502 U.S. 994 (1991); citing Simmons v. U.S. Army Corps of Eng'rs, 120 F.3d 664, 666 (7th Cir. 1997)).

[16] 40 C.F.R. § 230.10(a)

[17] 33 U.S.C. § 2289a

In developing and selecting alternatives, the DEIS must also comply with the full suite of federal laws and policies designed to protect the environment. These include, the Endangered Species Act, the Clean Water Act, the Fish and Wildlife Coordination Act, the Migratory Bird Treaty Act, and the mitigation requirements applicable to Corps civil works projects that were established by § 2036(a) of the Water Resources Development Act of 2007. These mitigation requirements must be satisfied, among other times, whenever the Corps will be recommending a project alternative in an EIS.[18] . The alternative ultimately recommended must also obtain a Clean Water Act water quality certification from the State of Mississippi.

In addition, the DEIS is missing information critical information necessary to evaluate the significant effects of the proposed alternative including:

- App. B—Public Comments (placeholder only): should supply scoping comments.
- App. C—State and Agency Comments (placeholder only): should supply scoping comments.
- App. D-2—Fish and Wildlife Coordination Act Report (placeholder only): critical for understanding Fish and Wildlife Service views on the impacts to fish and wildlife.
- App. E—Programmatic Agreement (placeholder only): critical as we understand this could place controls on changes to operating plans, among other things.
- App. G—Threatened and Endangered Species (placeholder only): critical for assessing impacts to threatened and endangered species.
- Economic Analysis and Benefit-Cost Assessment: critical for assessing the viability of the proposed alternatives and the key beneficiaries.
- Mandatory Independent External Peer Review: critical for assessing the quality of the DEIS.

The DEIS must undergo Independent External Peer Review (IEPR) as required by 33 U.S.C. § 2343. IEPR is mandatory since the Preferred Alternative would cost well over $200 million and is unquestionably controversial[19] as "there is a significant public dispute as to the size, nature, or effects of the project" and "there is a significant public dispute as to the economic or environmental costs or benefits of the project."[20]

As the Corps is well aware, "in all cases" the IEPR review must be carried out concurrently with the project study and must be completed "not more than 60 days after the last day of the public comment period for the draft project study," unless the Chief of Engineers determines that more time is necessary.[21] The Corps provides IEPR plans online, and is required by law to

[18] 33 U.S.C. § 2283(d)
[19] 33 U.S.C. § 2343(a).
[20] 33 U.S.C. § 2343 (a)(4).
[21] 33 U.S.C. §§ 2343(b) and 2343(d).

provide the public with information on the timing of the IEPR, the entity that has the contract for the IEPR review, and the names and qualifications of the IEPR panel members.[22]

3. The Seasonal Operations Plan is Vulnerable to Change

As described in Section 1 above, both Alternatives 2 and 3 include a seasonal operating plan to manage water levels between 90 and 93 ft NGVD. The DEIS does not include an actual operating plan, leaving the public with no ability to assess the actual impacts of that plan. We expect that the operating plan will include options for multiple deviations from the plan's typical parameters as USACE operating plans typically do. If the operating plan does change, project-induced impacts could increase well above the already unacceptable levels currently identified in the DEIS.

It is likely that the operating plan will change. The Corps' regulations require the Corps to "keep approved water control plans up to date" including by subjecting those plans "to continuing and progressive study by personnel in field offices of the Corps of Engineers."[23] The Corps' Engineering Regulations also direct that water control plans should be reviewed "no less than every 10 years and shall be revised as needed in accordance with this regulation."[24] The Engineering Regulations also allow "[s]ignificant, recurrent or prolonged deviations from operations prescribed by an approved water control plan" unless the division commander decides that such deviations "indicate a need for a formal change to operations prescribed by an approved water control plan."[25]

The DEIS states "additional Memorandums are being developed related to Pump Operations and Monitoring and Adaptive Management of the Water management Project to establish procedures regarding efficient and effective coordination in the development, review, approval, and oversight of these plans." Unfortunately, such agreements are unenforceable and vulnerable to change and political pressure. The Yazoo Pumps have already been the subject of intense political pressure. In public comment sessions on this DEIS, pumps proponents have repeatedly stated a desire for altering the proposed operating plans to facilitate longer growing seasons in public comment sessions.

When the operating plan does inevitably change, there is no requirement to notify the resource agencies or the public of any such deviations. It will also be difficult—and perhaps impossible—for resource agencies or the public to know whether the Corps is in fact following the operating plan or deviating from it during a particular flood event. As a result, the operating plan for the selected alternative cannot provide a reliable backstop for managing environmental harm or

[22] 33 U.S.C. § 2343.
[23] 33 CFR 225(f)(2).
[24] ER 1110-2-240, Water Control Management (30 May 2016) at paragraph 3-2j
[25] ER 1110-2-240, Water Control Management (30 May 2016) at paragraph 3-2j.

selecting the least environmentally damaging practicable alternative, as required by the Clean Water Act.

4. Impacts

The DEIS states that Alternative 2 would have "indirect impacts" associated with changes in flood duration levels, attributed to pump station operation resulting in a loss of 34,687 Acreage Annual Functional Capacity Units (AAFCUs) necessitating an estimated 7650 acres of reforested compensatory mitigation lands, while Alternative 3 would result in a loss of 25,470 AAFCUs, necessitating an estimated 5,722 acres of reforested compensatory mitigation lands. American Rivers is concerned that this finding of impacts to wetlands, and the corresponding impacts to species, are drastically understated because the data included in Table 53 in Appendix F-3-Wetlands indicates that the impacts to wetlands and associated species, resulting from keeping water levels at or below the 90-foot elevation—the 2-year floodplain—throughout the entire migration, breeding, spawning, and rearing periods, would far exceed the Corps' estimate.

The EPA has yet to release their Determination which will assess the wetland impacts of the Preferred Alternative, and the FWS has not yet released their Fish and Wildlife Coordination Act Report which will assess impacts on fish and wildlife and Threatened and Endangered Species. As Alternatives 2 and 3 will include an operating plan that will alter the timing, and reduce the spatial extent, depth, frequency, and duration of time that wetlands within the project area are inundated, these reports are expected to find that Alternatives 2 and 3 will undoubtedly result in significant impacts to the hemispherically important wetlands in the Yazoo Backwater Area and the many species that depend upon this region.

The Yazoo Backwater Area "contains some of the richest natural resources in the nation including a highly productive floodplain fishery, one of only a few remaining examples of the bottomland hardwood forest ecosystem which once dominated the Lower Mississippi Alluvial Valley, and is one of only four remaining backwater ecosystems with a hydrological connection with the Mississippi River."[26] Forested wetlands have long been recognized as vitally important and as being "among the Nation's most important wetlands."[27] The bottomland hardwood wetlands of the Lower Mississippi River Valley: "are prime overwintering grounds for many North American waterfowl, including 2.5 million of the 3 million mallards of the Mississippi Flyway, nearly all of the 4 million wood ducks and many other migratory birds. Numerous finfishes depend on the flooded hardwoods for spawning and nursery grounds. These wetlands support many other species of wildlife, including deer, squirrel, raccoon, mink, beaver, fox and rabbit. They also play a vital role in reducing flooding problems by temporarily storing large quantities of water and by slowing the velocity of flood waters. In the process, these wetlands

[26] U.S. Fish and Wildlife Service, Fish and Wildlife Coordination Act Report (October 23, 2006), 2007 Final SEIS, Appendix 3 at 1.
[27] Report to Congress, Secretary of the Interior, Impact of Federal Programs on Wetlands, 1988, Volume I at 39.

remove chemicals such as fertilizers and pesticides from the water, trap soil eroding from nearby farmlands, and recharge ground water supplies."[28]

As the EPA stated in the 2008 Clean Water Act veto of the pumps, the "construction and operation of the proposed Pumps would dramatically alter the timing, and reduce the spatial extent, depth, frequency, and duration of time that wetlands within the project area are inundated."[29] The ecological implications of these changes are enormous, because hydrology is "the single most important determinant of the establishment and maintenance of specific types of wetlands and wetland processes."[30]

In addition, the actual impacts from Alternatives 2 and 3 may be far greater than acknowledged in the DEIS because the DEIS fails to assess an extensive array of impacts to fish and wildlife. A full analysis of impacts to fish and wildlife is necessary given the importance of the Yazoo Backwater Area's ecologically rich wetlands to more than 450 species of birds, fish, and wildlife. EPA issued the 2008 Clean Water Act veto because the Yazoo Pumps "would result in unacceptable adverse effects on fishery areas and wildlife," highlighting the loss of spring flood pulses as of particular concern as those coincide with and support key lifecycles of fish and wildlife. Indeed, the veto "is based solely on environmental harms to fisheries and wildlife in the Yazoo Backwater Area" as "is appropriate given the structure and language of the CWA and case law."[31] In the veto, EPA also noted that the U.S. Fish and Wildlife Service "concurred with EPA's conclusion that the Yazoo Backwater Area Project would result in significant degradation and unacceptable adverse effects on wildlife and fisheries resources" and expressed appreciation for the veto acknowledging "the full breadth of the proposed project's anticipated adverse impacts to its four National Wildlife Refuges located within the project area."[32]
A careful and robust assessment of these needs is critically important for understanding the true extent of adverse impacts to fish and wildlife because the Yazoo Pumps Alternatives will keep water levels at extremely low elevations during the time periods that are most critical for migration, breeding, spawning, and rearing.

5. Resilience Alternative

As mentioned previously, American Rivers remains concerned that the local community members requesting a whole of government solution that focuses on non-structural and nature-based approaches have not been fully considered. American Rivers continues to join our regional and local partners in urging the Corps to pursue a Resilience Alternative that utilizes

[28] Id.
[29] 2008 Final Determination at i.
[30] William J. Mitsch and James G. Gosselink, *Wetlands* (5th ed.) (2015) at 112 (emphasis in original).
[31] Clean Water Act 404(c) Final Determination at 70.
[32] Clean Water Act 404(c) Final Determination at 20. The Department of the Interior had previously concluded that the Yazoo Pumps "will have unacceptable adverse effects on fishery areas, including spawning and breeding areas" and "unacceptable adverse effects on wildlife, specifically to the area's breeding and migratory birds, including landbirds, shorebirds, wading birds, and waterfowl." U.S. Department of the Interior Comments on the 2007 FSEIS at 7, 9.

the entire capability of the federal government to deliver real solutions that not only reduce flood damages but invest in the communities in the region.

While the DEIS includes a fully nonstructural alternative, Alternative 4, that consists of voluntary acquisition of the 1,845 structures within the area flooded in 2019, and 137,926 acres of farmland that could be acquired via fee or easement, American Rivers is disappointed the Corps did not develop a more robust nonstructural alternative that brings together the many potential programs and resources available through the federal government to collectively build a plan that will not only reduce flood risk, but will address the systemic challenges and foster economic growth within the economically disadvantaged communities in the Yazoo Backwater Area, such as the Resilience Alternative included in Attachment 1 to these comments. The Resilience Alternative will avoid flood risks and reduce flood damages to impacted communities while protecting and restoring—instead of harming—this ecologically rich area. The Resilience Alternative unquestionably complies with the Clean Water Act 404(b)(1) Guidelines, the Endangered Species Act, and all other applicable environmental laws.

The Resilience Alternative utilizes sustainable solutions that are being employed by communities across the country to reduce flood risks, including purchasing wetland reserve and floodplain easements, voluntary buyouts and relocations, and flood-proofing infrastructure. These solutions can be carried out under existing federal programs that are currently funded and available for use in the Yazoo Backwater Area, including: U.S. Department of Agriculture easement programs; Federal Emergency Management Agency pre-disaster mitigation programs (which are being consolidated under the new Building Resilient Infrastructure and Communities "BRIC" program); and Federal Emergency Management Agency post-disaster recovery programs.

Conclusion

American Rivers calls on the Corps to respect the 2008 EPA veto of this project and end the effort to build a 25,000 cfs pumping station at Steele Bayou. The Administration's decision to reassert the Yazoo Pumps Clean Water Act veto in November 2021 opened the door for deploying demonstrably effective natural, nature-based and non-structural solutions for the Yazoo backwater Area. These solutions would reduce flood risks for vulnerable Yazoo backwater communities while protecting and restoring the region's hemispherically significant wetlands and making communities and the nation's wildlife more resilient to climate change. Local community leaders, the conservation community, hundreds of scientists, the U.S. Fish and Wildlife Service, the U.S. Environmental Protection Agency, and others have repeatedly asked the Corps to deploy these types of solutions for the Yazoo backwater area. American Rivers urges the Corps to support the prompt deployment of these types of solutions, and abandon pursuit of the environmentally devastating, dangerous, extremely costly, and long-vetoed Yazoo Pumps.

Thank you for your consideration of our comments. If you have any questions, please contact Eileen Shader, Senior Director of Floodplain Restoration, at eshader@americanrivers.org. We appreciate this opportunity to provide comments on the Yazoo Backwater Area, and we look forward to your response.

Sincerely,

Eileen Shader, CFM
Senior Director, Floodplain Restoration

Yazoo Backwater Area A Resilience Alternative

Strategic use of voluntary wetland reserve easements, restoration, and non-structural measures can reduce flood risks for vulnerable communities in the Yazoo Backwater Area (YBWA) of Mississippi, make those communities and the nation's wildlife more resilient to climate change, and advance the vitally important 30x30 Initiative by permanently protecting 80,000 acres of critical wetlands. These commonsense measures could be implemented through existing federal programs under the direction of an interagency task force convened by the Council on Environmental Quality and led by the U.S. Fish and Wildlife Service, U.S. Department of Agriculture, and Federal Emergency Management Agency.

The hemispherically significant wetlands in the YBWA are "some of the richest wetland and aquatic resources in the nation."[1] They support 450 species of birds, fish and wildlife; are used by 29 million migrating birds each year; and include tens of thousands of acres of federal, state, and privately-owned conservation lands. Critically, these wetlands help protect YBWA communities by storing hundreds of billions of gallons of floodwaters, improving water quality, and sequestering carbon. To prevent unacceptable damage to more than 67,000 acres of these vital wetlands, the Environmental Protection Agency used its Clean Water Act 404(c) authority in 2008 to veto the Yazoo Pumps. This veto paved the way for the subsequent protection of an additional 53,300 acres of YBWA wetlands through conservation easements and other voluntary mechanisms.

But in a reckless about-face and in direct violation of the law, the Trump Administration hastily revoked the 2008 veto and then approved the Yazoo Pumps just days before President Biden was sworn in to office. The Corps refused to consider this Resilience Alternative—or any other alternative to the destructive and ineffective Yazoo Pumps—despite repeated requests to do so. The Corps' decision was opposed by the U.S. Fish and Wildlife Service, 110 scientific professionals, four scientific associations, 120 conservation and social justice organizations, and more than 55,000 members of the public.

The $450 million Yazoo Pumps will drain tens of thousands of acres of wetlands to subsidize large-scale agribusiness operations that have already received $1.05 billion in farm subsidies.[2] The Yazoo Pumps are <u>not</u> designed to protect communities and will <u>not</u> prevent flooding.[3] The Pumps will leave 82% to 89% of flooded lands underwater, take weeks to months to drawdown floodwaters on the remaining lands, and increase flood risks for downstream frontline communities.[4]

The Biden Administration can deliver immediate, sustainable flood relief to underserved communities in the YBWA while protecting nationally significant wildlife resources by reconfirming EPA's 2008 veto of the Yazoo Pumps, withdrawing the fatally flawed Record of Decision approving the project, and appointing an interagency task force to implement the Resilience Alternative outlined below.

Targeted Use of Existing Federal Programs in the Yazoo Backwater Area

Flooding in the YBWA is primarily restricted to conservation lands managed as wetland systems, low-lying marginal agricultural lands targeted for restoration by the Lower Mississippi Valley Joint Venture, and other low-lying, sparsely populated areas.[5] Strategic implementation of existing federal programs can protect communities in the YBWA, while also achieving the area's critical restoration goals.

The programs outlined below authorize and fund the voluntary wetland reserve easements, restoration, and non-structural measures that are part of this Resilience Alternative. Strategic use of these measures can be achieved through an interagency task force led by the U.S. Fish and Wildlife Service, U.S. Department of Agriculture, and Federal Emergency Management Agency.

Federal Program	Structures	Agricultural Lands	Community Facilities	Roads, Bridges Utility Systems
Wetland Reserve Easements (WRE) **USDA**		✓		
Floodplain Easement Program **USDA**	✓	✓		
Building Resilient Infrastructure and Communities (BRIC) **FEMA – Pre-Disaster Mitigation**	✓		✓*	✓
Flood Mitigation Assistance (FMA) **FEMA – Pre-Disaster Mitigation**	✓		✓*	✓
Hazard Mitigation Grant Program (HMGP) **FEMA – Post-Disaster Recovery**	✓		✓	✓
Community Facilities Grant Program **USDA – Post-Disaster Recovery**	✓		✓	

*With some limitations. Other federal programs, including the HUD Community Development Block Grants-Disaster Recovery Program, are also available to assist with post-disaster recovery subject to targeted appropriations.

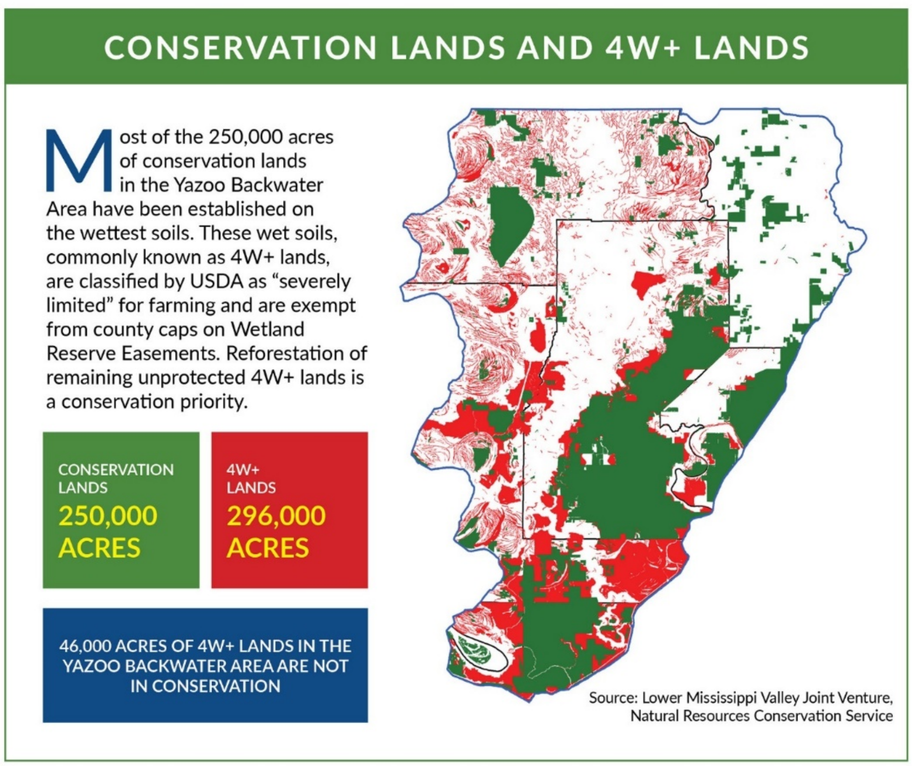
The benefits of these measures could be amplified by an innovative marketing campaign to stimulate wildlife and cultural heritage-associated tourism in the YBWA developed in collaboration with the Mississippi Delta National Heritage Area, the Delta Blues Trail, the Delta National Forest, and the Theodore Roosevelt National Wildlife Refuge Complex. The Delta Interpretive Center, which will be housed in the newly constructed Theodore Roosevelt Wildlife Refuge Visitor Center, could be a centerpiece of this effort.[6] Funding for such a campaign could be sought through the Mississippi Delta National Heritage Area Grant Program.[7]

Diversifying the economy of the YBWA in this manner would provide a substantial lifeline to the region's struggling economy. Outdoor recreation in Mississippi generates $8 billion in consumer spending, $620 million in state and local tax revenue, and 79,000 jobs.[8] In 2011, state residents and nonresidents spent $2.63 billion on wildlife recreation in Mississippi.[9] The demand for wildlife-related recreation is increasing nationwide and directing more of this demand to the YBWA could produce significant economic benefits for the region's rural, low income communities.

1. Wetland Reserve and Floodplain Easement Programs (USDA)

Goal: Enroll at least **80,000 acres** of YBWA lands in the Wetland Reserve Easement (WRE) and Floodplain Easement Programs managed by the U.S. Department of Agriculture. These easements should be targeted towards marginal croplands (those with 4W+ soils) adjacent to existing conservation lands, croplands inundated during the 2019 floods, croplands within the acquisition boundaries established for the National Wildlife Refuges in the YBWA, and croplands targeted for restoration by the Lower Mississippi Valley Joint Venture. Floodplain easements should also target frequently flooded residential properties.

This goal is supported by extensive planning assessments, GIS analyses, and the best available conservation science which have been used to identify 80,000 acres of conservation and reforestation priorities for the YBWA. The USDA has classified 46,000 acres of unprotected lands in the YBWA as 4W+ lands, which means they are "severely limited" for agriculture because they are saturated at least 50% or more of the growing season. These 4W+ lands, most of which are adjacent to existing conservation lands, are a priority for WRE enrollment and are exempt from WRE enrollment and county wide caps.



The Lower Mississippi Alluvial Valley Joint Venture has identified 60,000 acres (which includes 20,000 acres of the unprotected 4W+ lands described above) as priorities for restoration and protection to benefit wetland forest breeding birds (e.g. Prothonotary Warbler, Wood Thrush, Wood Duck, Wild Turkey, Swallow-tailed Kite). Restoring and protecting bottomland hardwood forests also benefits other forest-dependent wildlife, including Louisiana Black Bear, at-risk bat species, and the swamp rabbit.

Prothonotary Warblers rely heavily on the Yazoo Backwater Area during spring migration.
Photo: Gary Robinette/Audubon Photography Awards

Responsible Federal Agency and Partners: U.S. Department of Agriculture (Natural Resources Conservation Service) working with landowners, homeowners, communities, and non-governmental organizations.

Funding: Both programs are funded and regularly accept proposals for enrollment.

Multiple Benefits: Restoring enrolled lands to healthy wetlands would provide multiple benefits.

- **Reducing Flood Risks:** Restoring enrolled lands would provide significant flood damage reduction benefits, reduce emergency response costs, and help create safer and healthier communities. A single acre of wetland can store 1.5 million gallons of floodwater,[10] preventing flood damages. For example, wetlands prevented $625 million in flood damages in the 12 coastal states affected by Hurricane Sandy, and reduced damages by 20% to 30% in the four states with the greatest wetland coverage.[11] In its flood damage reduction recommendation for the Charles River in Massachusetts, the Corps of Engineers concluded that: "Nature has already provided the least-cost solution to future flooding in the form of extensive [riverine] wetlands which moderate extreme highs and lows in streamflow. Rather than attempt to improve on this natural protection mechanism, it is both prudent and economical to leave the hydrologic regime established over millennia undisturbed."[12]

- **Improving Water Quality and Groundwater Recharge:** Restoring enrolled lands will help purify water supplies, reduce nutrient loading into streams and rivers, and recharge groundwater in the YBWA. Irrigation in the Mississippi Delta, including the YBWA, has caused some of the most severe groundwater declines in the United States and highly damaging low-flow conditions in many Delta streams. Recent studies demonstrate the significant value of wetlands to groundwater recharge in the YBWA.[13]

- **Providing Vital Wildlife Habitat:** Restoring enrolled lands will provide essential benefits to fish and wildlife in the YBWA and beyond. Wetlands are some of the most biologically productive natural ecosystems in the world, and support an incredibly diverse and extensive array of fish and wildlife. The wetlands in the YBWA support 450 species of birds, fish and wildlife and are used by 29 million migrating birds each year. The YBWA contains one of the last existing and most substantial tracts of highly productive bottomland hardwood forests in the Lower Mississippi River Alluvial Valley, and the U.S. Fish and Wildlife Service has determined that the YBWA is the area with the "greatest potential" for meeting breeding bird habitat restoration and protection needs within the Mississippi Alluvial Valley.[14] Restoring wetlands in the YBWA is a conservation priority for the Lower Mississippi Valley Joint Venture. An additional 1.73 million acres of sustainable forest habitat are needed in the Mississippi Alluvial Valley to attain population goals for most forest-dependent bird species in the region.[15]

- **Sequestering Carbon:** The Mississippi Alluvial Valley was an early proving ground for carbon sequestration through forest restoration and protection. In the 1990's public utilities provided millions of dollars to voluntarily offset their carbon emissions by expanding carbon sequestration on private lands and federal wildlife refuges. There is now renewed interest in facilitating, funding and expanding carbon sequestration incentives on private land in the region.

- **Creating Jobs and Economic Activity:** Restoration work associated with easement enrollment would create jobs. In Mississippi, the Fish and Wildlife Service Partners for Wildlife Program created 29.7 jobs for each million dollars spent on restoration, and $1.63 of economic activity for each dollar spent on restoration in FY2011.[16]

- **Reducing National Flood Insurance Program Rates:** Protecting floodplains has the largest impact on lowering National Flood Insurance Program (NFIP) rates for communities participating in the voluntary Community Rating System Program (CRS). Participation in the CRS can reduce NFIP rates from 15% to 45%. The CRS credits over 90 elements of comprehensive floodplain and watershed management, including significant credits for preserving natural floodplain open space, acquiring flood-prone land and returning it to its natural state, and protecting and restoring natural floodplain functions and habitat.

- **Avoiding Farm Subsidy Costs:** Enrolling cropped wetlands in Wetland Reserve Easements reduces the costs of commodity, federal crop insurance, and noninsured crop disaster assistance programs. A recent study documents these avoidance benefits (present value of avoided costs less the Wetlands Reserve easement and restoration costs) in Mississippi at $870 per acre.[17]

Program Details—Wetland Reserve Easements:

- Cropped and forested lands can be enrolled in the Wetland Reserve Easement Program (WRE) . Enrolled lands are taken out of agricultural production and restored to wetlands.
- Enrollment provides direct payments to landowners, currently up to $3,100 per acre.[18] USDA also pays to restore the enrolled lands. Landowners can make additional profits by selling or leasing the land for hunting, fishing, or other uses compatible with maintaining the restoration. Landowners may also be eligible for a tax deduction.
- Lands classified by USDA as 4W+ are "severely limited" for agriculture because they are saturated at least 50% or more of the growing season. The 2014 Farm Bill exempted 4W+ lands from WRE enrollment and county-wide caps. At least 46,000 acres of 4W+ lands in the YBWA are not in conservation, with many of these acres adjacent to existing conservation lands.
- The WRE program is extremely popular in Mississippi. At least 186,000 acres—including almost 80,000 acres in the YBWA counties—have already been enrolled in the WRE program in

Mississippi (in both the Wetlands Reserve Program and WRE programs which are now combined), according to the NRCS.

Program Details—Floodplain Easements:

- Both cropland and residential properties may be enrolled in the USDA Floodplain Easement program. Cropped lands are taken out of agricultural production and restored. Structures located within the area of a floodplain easement are demolished and removed, or relocated outside of the affected floodplain, and the lands are then restored.
- Enrollment provides direct payments to landowners, currently up to $3,100 per acre.[19] USDA pays to restore the enrolled lands. USDA also pays the costs of demolishing and removing, or relocating structures out of the affected floodplain. Landowners can make additional profits by selling or leasing the land for hunting, fishing, or other uses compatible with maintaining the restoration. Landowners may also be eligible for a tax deduction.

2. Pre-Disaster Mitigation Programs (FEMA)

Goal: Significantly expand pre-disaster mitigation planning and protection in the YBWA to reduce the risk of damage from future high water events and increase community resilience.

Responsible Federal Agency and Partners: Federal Emergency Management Agency working with the State of Mississippi and local governments.

Funding: FEMA's Building Resilient Infrastructure and Communities (BRIC) Grant Program and Flood Mitigation Assistance Program are well funded and accept proposals yearly. FEMA can provide free Flood Risk Management Workshops for elected officials and community administrators to assist communities in reducing flood risks and increasing resilience.

Benefits: Significant public benefits through creation of safer communities by improving resilience, eliminating impacts of future flood events, and providing long-term solutions to flooding problems. Effective pre-disaster mitigation reduces loss of life and property damage from future floods, minimizes flood disaster disruptions, and allows more rapid recovery when flooding does occur. On average, $1 spent on hazard mitigation through a federally funded mitigation grant saves $6 in future disaster costs. Federal grants provide $7 in benefits for each $1 invested in riverine flood mitigation.

Program Details—FEMA BRIC Program:

- The BRIC Program provides funding to states, tribes, and local communities to reduce overall risk to the population and structures from future hazard events and increase community resilience through funding hazard mitigation projects and activities.
- The BRIC priorities are to incentivize: public infrastructure projects; projects that mitigate risk to one or more lifelines; projects that incorporate nature-based solutions; and adoption and enforcement of modern building codes.
- The BRIC program typically covers up to 75% of eligible activity costs, but "small impoverished communities" are eligible for coverage of up to 90% of eligible costs. A small impoverished community is an economically disadvantaged community with 3,000 or fewer individuals having an average per capita annual income not exceeding 80% of the national per capita income.
- The BRIC program is funded through a 6% equivalency set-aside of all disaster expenditures from the Disaster Relief Fund. The BRIC program was funded at $500 million in FY20.

Program Details—FEMA Flood Mitigation Assistance Program:

- The Flood Mitigation Assistance (FMA) Program provides funding to states, tribes, and local governments to reduce or eliminate the risk of repetitive flood damage to buildings and structures insured under the National Flood Insurance Program. FMA funding may cover up to 100% of costs to address severe repetitive loss properties and up to 90% of costs to address repetitive loss properties. Other activities will be funded up to 75%.
- The FMA program was funded at $200 million in FY20.

Program Details—Floodplain Management Training:

- FEMA can provide free Flood Risk Management Workshops for elected officials and community administrators to assist communities in reducing flood risks and increasing resilience. Trainings include information on the National Flood Insurance Program, including its history, standards, regulations and administration; floodplain mapping; flood hazard mitigation; and floodplain management for environmental benefits. FEMA can also provide additional relevant trainings in the YBWA through its Integrated Emergency Management Course.

- The Association of State Floodplain Managers (ASFPM) offers a Certified Floodplain Management program for public and private sector professionals that compliments the FEMA floodplain management trainings. Anyone can join ASFPM and take the CFM exam for a nominal fee. ASFPM members and Certified Floodplain Managers© have access to unique resources that can help their communities more effectively administer FEMA programs, reduce flood insurance rates, and minimize flood damages.

3. Post-Disaster Recovery Programs (FEMA, USDA, HUD)

Goal: Prioritize disaster recovery funds to voluntary buy-outs and elevations of "severe repetitive loss" and "repetitive loss" properties in the YBWA, and improve essential community infrastructure.[20] FEMA has identified 198 severe repetitive loss properties in Issaquena and Sharkey counties (which are located entirely within the YBWA).[21]

Responsible Federal Agencies and Partners: Federal Emergency Management Agency, U.S. Department of Agriculture, U.S. Department of Housing and Urban Development (depending on program used), working with the State of Mississippi, local governments, property owners, and residents.

Funding: The FEMA Hazard Mitigation Grant Program is funded and accepts applications from state and local governments in areas covered by a Presidential disaster declaration. The USDA Community Facilities Grant Program is funded and accepts applications from rural communities with up to 20,000 residents in areas covered by a Presidential disaster declaration. Supplemental appropriations targeted to the YBWA would be required to take advantage of the HUD Community Development Block Grants – Disaster Recovery program and the HUD Community Development Block Grants – Mitigation program.

Benefits: Significant public benefits, including reducing flood risks and emergency response costs, creating safer and healthier communities, and restoring vital floodplain habitat. Increasing the resilience of roads and other community infrastructure improves community well-being and supports economic development. Homeowners are compensated for moving out of harm's way or elevating homes and other structures to avoid future flood damages. Targeting buy-outs to the YBWA would help refocus the HMGP program, which historically has disproportionately funded buy-outs in white communities rather than communities of color.

Program Details—FEMA Hazard Mitigation Grant Program:

- The FEMA Hazard Mitigation Grant Program (HMGP) provides grants to state and local governments in areas covered by a Presidential disaster declaration. FEMA accepts HMGP applications for **one year** after a federal disaster declaration with the possibility of up to a 180-day extension at the state's request. Approximately 70% of FEMA buy-out projects are approved within two years of the associated disaster.
- HMGP grants can be used to purchase flood-damaged properties from willing sellers at pre-flood values and preserve the land as open space, or to elevate structures.
- Any structure in the 100-year floodplain (*i.e*., a Special Flood Hazard Area) valued at up to $276,000 automatically qualifies for a FEMA-funded buy-out, and any structure in a Special Hazard Area valued at up to $175,000 automatically qualifies for a FEMA-funded elevation. Other structures may also qualify if the buy-out or elevation would be cost-effective.
- The YBWA was eligible for HMGP grants through the April 23, 2019 Federal Disaster Declaration 4429 (as amended), which made FEMA's HMGP available to the entire state of Mississippi. Extending this Disaster Declaration would ensure that funding is available for the HMGP program in the YBWA, and any future applicable disaster declaration would re-trigger the availability of post-disaster recovery funds and programs to the YBWA.
- FEMA has funded **638 buy-outs in Mississippi, including 105 in Warren County**, since the 1980s. In all, FEMA has funded the buy-out of more than 43,360 properties through 3,839 "projects" in 49 states. Of these properties, 96% suffered from river flooding or intense rains, while 4% suffered from coastal flooding. The HMGP has funded 96% of all FEMA buy-outs.
- Targeting buy-outs to the YBWA would help refocus the HMGP program, which historically has disproportionately funded buy-outs in white communities rather than communities of color, according to a 2019 NPR investigation. For example, after the 2008 floods in Iowa, "households in high social vulnerability areas were less likely to obtain full financial compensation" from federally funded buyout programs and waited longer to receive acquisition funds.

Program Details—USDA Community Facilities Grant Program:

- The USDA Community Facilities Grant Program provides grants to rural communities with up to 20,000 residents in areas covered by a Presidential disaster declaration. Funding under this grant program can be used to advance more than 100 types of projects, including the purchase, construction, or improvement of essential community facilities. Essential community facilities include such things as health care facilities, town halls, courthouses, community centers, fairgrounds, police and fire departments, libraries, museums, and food banks.
- The 2019 Additional Supplemental Appropriations for Disaster Relief Act appropriated $150 million for grants under this program in areas where FEMA provided a notice declaring a Major Disaster Declaration, which includes the YBWA.

Program Details—HUD Community Development Block Grants – Disaster Recovery:

- The HUD Community Development Block Grants-Disaster Recovery Program (CDBG-DR) supplements FEMA disaster recovery funds to help cities, counties, and states recover from Presidentially-declared disasters, especially in low-income communities. Activities funded through these flexible grants must meet one of three national objectives: benefit low-and-moderate-income persons; aid in the prevention or elimination of slums or blight; or meet other community development needs having a particular urgency because existing conditions pose a serious and immediate threat to the health or welfare of the community where other financial resources are not available to meet such needs.

- Significant funding can be obtained through the CDBG-DR grant process. For example, Mississippi is currently finishing up two CDBG-DR grants for Hurricane Katrina recovery ($5.06 billion and $423 million) and a third CDBG-DR grant for the 2008 storms ($11.7 million).

Program Details—HUD Community Development Block Grants – Mitigation:

- HUD Community Development Block Grants—Mitigation (CDBG-MIT) may be provided to CDBG-DR grant recipients to "carry out strategic and high-impact activities to mitigate disaster risks and reduce future losses" including by supporting data-informed investments in high-impact mitigation projects; building state and local government capacity for comprehensively analyzing disaster risks; supporting adoption of policies that minimize future disaster costs; and maximizing the impact of funds by leveraging other funding sources.
- Congress appropriated $12 billion in CDBG funds in February 2018 for mitigation activities related to qualifying disasters in 2015-2017, and HUD has allocated an additional $3.9 billion, bringing the amount available for mitigation to nearly $16 billion.

Targeting these available and funded programs to the YBWA would provide immediate, cost-effective, and sustainable flood relief to underserved communities in the YBWA while protecting nationally significant wildlife resources.

Endnotes

[1] U.S. Environmental Protection Agency, Final Determination of The U.S. Environmental Protection Agency's Assistant Administrator for Water Pursuant to Section 404(C) of the Clean Water Act Concerning the Proposed Yazoo Backwater Area Pumps Project, Issaquena County, Mississippi (August 31, 2008).

[2] USDA data compiled through the Environmental Working Group Farm Subsidy Database, shows that farms in the 16 zip codes that fall within the YBWA received a total of $1.05 billion in farm subsidy payments between 1995 and 2019, with the top 5 recipients receiving a total of $20.5 million, $17.4 million, $15.5 million, $14.2 million, and $10.7 million, respectively. The top 5 recipients in each zip code received a total of $430.7 million—an average of $215,000 for each of 80 recipients every year for 25 years—while 272 recipients received more than $1 million each for an average of $40,000 a year for each recipient every year for 25 years.

[3] Operation of the Yazoo Pumps would put downstream frontline communities on the receiving end of an additional 9 billion gallons of water a day when the Yazoo River is already at flood stage. Communities in the Yazoo Backwater Area could flood if that massive influx of water overtopped or damaged the Yazoo Backwater Levee, which is at risk of crevassing and is so low that it is not accredited to handle a 100-year flood. Collapse of this levee would flood the very communities the pumps are purported to protect.

[4] 2020 Final Supplement No. 2 To The 1982 Yazoo Area Pump Project Final Environmental Impact Statement (FSEIS), Appendix C (Tables), Table 5.3 (the "sloped pool" model is the most accurate).

[5] Since completion of the Yazoo Backwater Levee in 1978, there has been a significant decline in the elevation of backwater floods, with water levels in the YBWA reaching the 20-year floodplain elevation just one time—during the unprecedented flood of 2019. From 1978 to 2018, water levels in the YBWA reached the 10-year floodplain just 2 times. By comparison, in 1973 flooding in the YBWA reached 101.48 feet, which is well above the 100 year floodplain elevation. U.S. Army Corps of Engineers Rivergages Website.

[6] The Theodore Roosevelt Wildlife Refuge Visitor Center is "one of the most significant investments in tourism infrastructure" in the Delta.

[7] The Mississippi Delta National Heritage Area, which includes all the YBWA counties, was established by Section 8008 of the Omnibus Federal Land Management Act of 2009, Pub. L. 111–11 (16 USC 461 note) to preserve and

promote the landscape, culture and history of the Mississippi Delta. Section 8008 authorizes appropriations of up to $1 million a year through 2024, and establishes a management authority and a local coordinating entity to assist in developing recreational and educational opportunities in the Heritage Area and increasing public awareness of, and appreciation for, natural, historic, scenic, and cultural resources of the Heritage Area.

[8] Outdoor Industry Association, Economic Value of Recreation in Mississippi 2017 (https://outdoorindustry.org/wp-content/uploads/2017/07/OIA_RecEcoState_MS.pdf).

[9] U.S. Fish and Wildlife Service, 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, State Overview, Table 3.

[10] Environmental Protection Agency, "Wetlands: Protecting Life and Property from Flooding." EPA 843-F-06-001. (2006) (factsheet).

[11] Narayan, S., Beck, M.B., Wilson, P., et al., The Value of Coastal Wetlands for Flood Damage Reduction in the Northeastern USA. Scientific Reports 7, Article number 9463 (2017), doi:10.1038/s41598-017-09269-z (available at https://www.nature.com/articles/s41598-017-09269-z).

[12] American Rivers, Unnatural Disasters, Natural Solutions: Lessons From The Flooding Of New Orleans (2006) (quoting USACE, from Massachusetts Department of Fish and Game, *Functions of Riparian Areas for Flood Control*, http://www.mass.gov/dfwele/river/pdf/riparian_factsheet_1.pdf.)

[13] Ying Ouyanga, et al., Estimating impact of forest land on groundwater recharge in a humid subtropical watershed of the Lower Mississippi River Alluvial Valley, Journal of Hydrology: Regional Studies 26 (2019) 100631 (wetlands in the lower Yazoo River Basin provide the highest rates of groundwater recharge while agricultural lands provide the lowest rates); Michael Gratzer, et al., Quantifying Recharge to the Mississippi River, Valley Alluvial Aquifer from Oxbow Lake-Wetland Systems, (2017) (oxbow lake wetlands near Belzoni, MS produce "significant vertical recharge" into the Mississippi River Valley Alluvial Aquifer).

[14] U.S. Fish and Wildlife Service, Fish and Wildlife Coordination Act Report (October 23, 2006), 2007 Final SEIS, Appendix 3 at 7.

[15] Elliott, A.B.; Mini, A.E.; McKnight, S.K.; Twedt, D.J. Conservation–Protection of Forests for Wildlife in the Mississippi Alluvial Valley. *Forests* 2020, *11*, 75 (available at https://www.mdpi.com/1999-4907/11/1/75).

[16] U.S. Fish and Wildlife Service, The Contribution of Partners for Fish and Wildlife Program and Coastal Program Restoration Projects to Local U.S. Economies (September 2013) at 18.

[17] Wetland Reserve Easement Program Economic Assessment: Estimated Commodity Program and Crop Insurance Premium Subsidy Cost Avoidance Benefits, Prepared for the Nature Conservancy (June 2, 2018) (authored by retired U.S. Department of Agriculture economist Dr. Doug Lawrence).

[18] In Mississippi, payments for enrolling lands in the WRE and Floodplain Easement Programs are the same. Easement purchase prices on forested land are slightly less than on cropland. The payment schedule is established by USDA on a yearly basis and may fluctuate slightly from year to year.

[19] Id.

[20] "Severe repetitive loss properties" are properties covered by the National Flood Insurance Program (NFIP) that have been the subject of four or more damage claims of more than $5,000 each, or two or more claims in which the insured structure sustained cumulative damage exceeding its fair market value. These structures, which are mostly homes, are priorities for elevation or removal. "Repetitive loss properties" are properties covered by the NFIP that have flood-related damage on two occasions where the cost of the repair equaled or exceeded 25% of the market value of the structure at the time of each such flood event; and the second incidence of flood-related damage increased the cost of flood-insurance compliance coverage.

[21] Of these severe repetitive loss properties, 150 are in Issaquena county and 48 are in Sharkey county. An additional 1,191 severe repetitive loss properties are located in Warren, Washington, and Humphreys counties, but large portions of these counties (and thus, many of these properties) are located outside the YBWA.

From: Mastrototaro, Jill <Jill.Mastrototaro@audubon.org>
Sent: Tuesday, August 27, 2024 4:30 PM
To: YazooBackwater MVK
Cc: GIPSON, JEREMIAH A COL USARMY CEMVK (USA); michael.l.connor10.civ@army.mil; jaime.a.pinkham.civ@army.mil; chelsea.a.haynes4.civ@army.mil; Colosimo, Robyn S SES USARMY HQDA ASA CW (USA)
Subject: [Non-DoD Source] Group Letter for Yazoo Backwater Study DEIS
Attachments: Group Letter Enforce Yazoo Pumps Veto_Final_8-27-24.pdf

Good Afternoon—

Attached please find a letter signed by 139 organizations for inclusion in the Army Corps' official public record for the Yazoo Backwater Study Area Draft Environmental Impact Statement.

Please acknowledge receipt of this email.

Thank you,
Jill

Jill Mastrototaro
Mississippi Policy Director
504.481.3659

Audubon Delta
PO Box 2026
Ridgeland, MS 39158

August 27, 2024

The Honorable Michael S. Regan
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, N. W.
Washington, D.C. 20460

Re: Protect Hemispherically Vital Wetlands in the Yazoo Backwater Area of Mississippi

Dear Administrator Regan:

On behalf of our millions of members and supporters, the 139 undersigned conservation, social justice, local government, professional, faith-based, and recreation organizations and businesses urgently ask you to protect the hemispherically significant wetlands in the Yazoo Backwater Area of Mississippi by enforcing your agency's long-standing Clean Water Act 404(c) veto protecting this area. These exceptional wetlands are once again at risk from the U.S. Army Corps of Engineers' (Corps) proposed Yazoo Backwater Pumping plant—an agricultural drainage project being promoted as flood control.

Many of us joined with more than 130 conservation and social justice organizations and dozens of community members to call on the Corps to abandon the Yazoo Pumps during the scoping phase for this latest proposal. We urged the Corps to instead deploy effective, environmentally sustainable non-structural, natural, and nature-based flood risk reduction measures that would benefit communities and wildlife.[1,2] But the Corps continues to pursue its plan[3] to build the largest pumping plant in the world to benefit industrial-scale agriculture on marginal lands that have always flooded. The water drained by these massive 25,000 cubic-feet-per-second pumps, up to 16 billion gallons a day, will be pushed into an already flooded Yazoo River, increasing flood risks for highly vulnerable downstream communities that suffer from pervasive and systemic environmental injustices.[4]

This version of the Yazoo Pumps would damage 89,800 to more than 93,300 acres[5] of vital wetlands—an area of wetlands **twice as large as Washington, D.C., and ten times larger than the area of wetlands protected by all other 404(c) vetoed projects combined.** Your agency has already determined that this

[1] Scoping comments on the Yazoo Backwater Area Pumping Plant (88 Fed. Reg. 43101) submitted by 133 conservation and social justice organizations on August 7, 2023 (available at https://waterprotectionnetwork.org/wp-content/uploads/2023/08/Group-Letter_Yazoo-Pumps-NOI_Final.pdf).

[2] Letter from 50 community members on the Yazoo Backwater Area Scoping Process submitted on August 4, 2023 (available at https://waterprotectionnetwork.org/wp-content/uploads/2023/08/Community-Letter_Corps-Yazoo-Scoping_8-4-23.pdf).

[3] The Corps identified the same plan as its preliminarily preferred plan in the Notice of Intent to Prepare an Environmental Impact Statement for the Yazoo Backwater Area Water Management Project, 88 Fed. Reg. 43101 (July 6, 2023).

[4] The Corps' plan also includes "mandatory buy-outs"—i.e., eminent domain and condemnation—of 52 homes in economically disadvantaged communities in the Yazoo Backwater Area.

[5] The Corps has identified two identical preliminary preferred alternatives (Alternatives 2 and 3) except for operating plans that differ by just 9 days. The Corps has proposed compensatory mitigation of just 5,722 to 7,650 acres, depending on the operating plan selected. U.S. Army Corps of Engineers, Draft Environmental Impact Statement for the Yazoo Backwater Area Water Management Project (July 2024) at 38, Wetland Appendix at 34.

plan would cause unacceptable impacts to “some of the richest wetland and aquatic resources in the nation” including vital bottomland hardwood wetlands that have long been recognized as being “among the Nation’s most important wetlands.”[6] These impacts are all the more unacceptable in light of the nation’s alarming increase in wetland losses[7] and the Supreme Court’s 2023 decision in *Sackett v. Army Corps of Engineers* that has left millions of acres of wetlands without Clean Water Act protection.

Fortunately, the Corps’ latest plan is explicitly barred by your agency’s long-standing veto, which prohibits “alterations to the spatial extent, depth, frequency, and duration of inundation of wetlands” that “would significantly degrade the critical ecological functions provided by approximately 28,400 to 67,000 acres of wetlands . . . in the Yazoo Backwater Area, including those functions that support wildlife and fisheries resources.”[8] The veto further confirms that more extensive ecological impacts would also be unacceptable.[9]

Under your leadership, EPA wisely reasserted this scientifically based veto in November 2021 to protect the region’s wetlands from the Corps’ attempt to resurrect the Yazoo Pumps under the previous administration.[10] This important decision to enforce the veto opened the door for deploying demonstrably effective natural, nature-based and non-structural solutions for the Yazoo backwater Area that would reduce flood risks for vulnerable communities while protecting and restoring the region’s hemispherically significant wetlands and making it more resilient to climate change. Your agency along with local community leaders, the conservation community, hundreds of scientists, the U.S. Fish and Wildlife Service, and others have repeatedly asked the Corps to deploy these types of commonsense solutions for the Yazoo Backwater Area.

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[6] Final Determination of the U.S. Environmental Protection Agency’s Assistant Administrator For Water Pursuant To Section 404(C) Of The Clean Water Act Concerning The Proposed Yazoo Backwater Area Pumps Project, Issaquena County, Mississippi, August 31, 2008 (Clean Water Act 404(c) Final Determination). The veto also makes it clear that the adverse effects of the Yazoo Pumps “are the result of a combination of operational factors including the capacity of the pumping station and its associated pump-on elevations.”
[7] Lang, M.W., Ingebritsen, J.C., Griffin, R.K. 2024. Status and Trends of Wetlands in the Conterminous United States 2009 to 2019. U.S. Department of the Interior; Fish and Wildlife Service, Washington, D.C. 43 pp.
[8] Id. at iii, 72.
[9] Id. at iii (“Although not proposed to go forward, FSEIS Plans 3, 4, and 7 . . . are expected to result in wetland impacts between approximately 28,400 and 118,400 acres” and “EPA has determined that each of these alternatives would also result in unacceptable adverse effects on fishery areas and wildlife.”)
[10] This decision put a stop to the previous administration’s Yazoo Pumps plan that was opposed by more than 110 scientific professionals, the Society of Wetland Scientists, the Society of Freshwater Science, the North American Lake Management Society, and more than 120 national, state and local conservation, faith-based, social justice, and recreation organizations among many others.

Instead of working to deploy these solutions through a whole of government approach, the Corps has once again recommended a massive pumping plant that will damage wetlands at a scale that this nation cannot afford. Our organizations call on you to prevent this from happening by enforcing the 2008 Clean Water Act 404(c) veto of the Yazoo Pumps.

Sincerely,

Stephanie Robinson
Co–Executive Director & Development Director
350 Wisconsin

Debra Campbell
Secretary and Treasurer
A Community Voice

Leo Carney
State Director
ADOS Empowerment Project

Kevin Shockey
Founder and Executive Director
Ahora Inc.

Pamela Miller
Founder and Executive Director
Alaska Community Action on Toxics

Eliza Evans
Climate Change Activist and Artist
All the Way to Hell

Eileen Shader
Sr. Director, Floodplain Restoration
American Rivers

Roxanne Blackwell
Managing Director of Government Affairs
American Society of Landscape Architects

Thomas Anderson
Administrative Director
Amigos de Bolsa Chica

Elizabeth Hartfield
President
Jackson Audubon Society

Sarah Gray
Owner
Jarden Native Plants designs

Pastor Dr. Charlotte L. Keys
CEO
Jesus People Against Pollution

Michael Washburn
Executive Director
Kentucky Waterways Alliance

Rylee Hince
Executive Director
Lake Pepin Legacy Alliance

Mayci Shimon
Leader
LandHealth Institute

Jazzari Taylor
Policy Advocate
Latino Outdoors

Sara Chieffo
Vice President, Government Affairs
League of Conservation Voters

Terese Grant
Co-President
League of Women Voters of Iowa

Harriet Festing
Executive Director
Anthropocene Alliance

Susan Anderson
Executive Director
Apalachicola Riverkeeper

Wanda Rios
President
Asociacion de Residentes de La Margarita, Inc.

Chad Berginnis
Executive Director
Association of State Floodplain Managers

Dean Wilson
Executive Director
Atchafalaya Basinkeeper

Jill Mastrototaro
Mississippi Policy Director
Audubon Delta

Jane Patterson
President
Baton Rouge Audubon Society

Usman Mahmood
Policy Analyst
Bayou City Waterkeeper

Lilias Jarding
Executive Director
Black Hills Clean Water Alliance

Zappa Montag
Ecological Activist
Black to the Land

Dr. Barry Kohl
President
Louisiana Audubon Council

Anne Rolfes
Director
Louisiana Bucket Brigade

Rebecca Triche
Executive Director
Louisiana Wildlife Federation

Mark River Peoples
COO
Lower Mississippi River Foundation

Steven Emerman
Owner
Malach Consulting

June Farmer
Director
Marin City People's Plan

Cynthia Robertson
Director
Micah Six Eight Mission

Pam Mitchell
Leader
Milton's Concerned Citizens/Save Blackwater River

Jennifer Bolger Breceda
Executive Director
Milwaukee Riverkeeper

Louie Miller
State Director
Mississippi Chapter Sierra Club

Charles Scribner
Executive Director
Black Warrior Riverkeeper

Anne Millbrooke
Designated Signer
Bozeman Birders

Myra Crawford
Executive Director
Cahaba Riverkeeper

Chris Shutes
Executive Director
California Sportfishing Protection Alliance

Brett Hartl
Govt Affairs Director
Center for Biological Diversity

Trish Rolfe
Executive Director
Center for Environmental Law & Policy

Jonathan Compton
Executive Director
Center for Environmental Transformation

Jane Conroe
Chair
Chautauqua-Conewango Consortium

John Koeferl
President
Citizens Against Widening the Industrial Canal

Deb Katz
Executive Director
CItizens Awareness Network

Melinda Repperger
Chapter President
Mississippi Coast Audubon Society

Romona Taylor Williams
Executive Director
Mississippi Communities United for Prosperity (MCUP)

Lea Campbell
Principal Organizer
Mississippi Rising Coalition

Colin Wellenkamp
Executive Director
Mississippi River Cities & Towns Initiative

Albert Ettinger
Counsel
Mississippi River Collaborative

Kelly
McGinnis
Mississippi River Network

Tamela Trussell
Founder
Move Past Plastic (MPP)

Brian Moore
Vice President of Coast Policy
National Audubon Society

Athan Manuel
Director, Lands Protection Program
National Sierra Club

Melissa Samet
Legal Director, Water Resources and Coasts
National Wildlife Federation

Susan Liley
Co-Founder
Citizens Committee for Flood Relief

Carin High
Co-Chair
Citizens Committee to Complete the Refuge

Jesse Deer In Water
Community Organizer
Citizens' Resistance At Fermi Two (CRAFT)

Marcy Brandenburg
Founder and Co-Chair
Clean Air For All Now

Sean Jackson
National Water Campaigns Coordinator
Clean Water Action

Sara Walling
Water & Agriculture Program Director
Clean Wisconsin

Gabriella Velardi-Ward
Co-Founder
Coalition for Wetlands and Forests

Dale Beasley
President
Columbia River Crab Fisherman's Association & Coalition of Coastal Fisheries

Clark Bullard
President
Committee on the Middle Fork Vermilion River

Michelle Smith
Marketing Director
Community In-Power and Development Association Inc. (CIDA Inc.)

Gerald Meral
California Water Program Director
Natural Heritage Institute

Jon Devine
Director, Freshwater Ecosystems
Natural Resources Defense Council

Carrie Clark
Executive Director
NC League of Conservation Voters

Vel Scott
President
New Image Life Skills Acadrmy Inc

Anni Hanna
Founder
New Mexico Climate Justice

Virginia Necochea
Executive Director
New Mexico Environmental Law Center

Yvonka Hall
Executive Director
Northeast Ohio Black Health Coalition

Gregory Remaud
Baykeeper & CEO NY/NJ Baykeeper
NY/NJ Baykeeper

Rich Cogen
Executive Director
Ohio River Foundation

Jennifer Coulson, Ph.D.
President
Orleans Audubon Society

Treva Gear
Founder and Chair
Concerned Citizens of Cook County

Susan Diane Mitchell
Founder and Co-Executive Director
Dynamite Hill-Smithfield Community Land Trust

Julian Gonzalez
Senior Legislative Counsel
Earthjustice

Jeff Moore
Board President
East Biloxi Food Market

Lydia Marie Kelley
Authorized Signer
Ebony Misses

Katherine Egland
Founder
Education, Economics, Environmental, Climate and Health Organization (EEECHO)

Dan Silver
Exeutive Director
Endangered Habitats League

Erin Kennedy
Executive Director
Environmental Defenders of McHenry County

Will McDow
Associate Vice President Climate Resilient Coasts and Watersheds
Environmental Defense Fund

L. Marie Kelley
Authorized Signer
Expertise Community Outreach

Aleta Toure
Coop Member
Parable of the Sower Intentional Community Cooperative

Tonyehn Verkitus
Executive Director
Physicians for Social Responsibility Pennsylvania

Louise Troutman
Executive Director
Pocono Heritage Land Trust

Mary O'Brien
Executive Director
Project Eleven Hundred

Eloy Ortiz
Special Projects Manager
Regeneración - Pajaro Valley Climate Action

Renee Fortner
Watershed Resources Manager
RiverLink

Terri Straka
Leader
Rosewood Strong Community

Diane Wilson
executive director
San Antonio Bay Estuarine Waterkeeper

Dawne Dunton
Founder

Saving Island Green Wildlife & Beyond

Yvonne Taylor
Vice President
Seneca Lake Guardian

Lowell Ashbaugh
Conservation Chair
Fly Fishers of Davis

Trevor Russell
Water Program Director
Friends of the Mississippi River

Ronald Stork
Policy Staff
Friends of the River

Michael Hansen
Executive Director
GASP

Steven Pulliam
President
Good Stewards of Rockingham

Fred Akers
Operations Manager
Great Egg Harbor Watershed Association

Krystal N. Martin
Founder
Greater Greener Gloster

Krystal N. Martin
CEO & Founder
Greater Greener Gloster Project

Sandra Lovely
Founder
Greater Neighborhood Alliance of Jersey City, NJ

Erin Meier
Director
Green Lands Blue Waters

Val Schull

Jacqueline Echols
President
South River Watershed Alliance

Virginia Richard
Gulf Program Director
SouthWings

Shannon Francis
Executive Director
Spirit of the Sun Inc

Jonathan Green
Executive Director
Steps Coalition

Laurie Ward
Leader
Stop the Lies. Stop the landfill

Michael Brown
Executive Director
Sustaining Way

John DeFillipo
Executive Director
Texas Conservation Alliance

Sharon Fisher
President
The Clinch Coalition

Arthur Johnson
CEO
The Lower 9th Ward Center for Sustainable Engagement and Development

Tyrone Pinkins
President
The Pyramid Project

Paul Botts

Water Equity and Ocean Program Director
GreenLatinos

Theaux M. Le Gardeur
Executive Director
Gunpowder RIVERKEEPER

Dr. Angela M Chalk
Executive Director
Healthy Community Services

Andrew Whitehurst
Water Program Director
Healthy Gulf

Susie McGovern
Water Science and Sustainability Specialist
Hoosier Environmental Council

Dr. Maureen Hackett
President & Founder
Howling For Wolves

Dimitra McCabe
Founder and Executive Director
HUBitual Learning and Outreach

Liz Stelk
Executive Director
Illinois Stewardship Alliance

Glenda Perryman
Executive Director
Immaculate Heart CDC

Anna Gray
Public Policy Director & Counsel
Iowa Natural Heritage Foundation

Jared Mott
Conservation Director
Izaak Walton League of America

Executive Director & President
The Wetlands Initiative

Joyce Tasby
Founder and CEO
The Young Peoples Guild

Ian Nakayama
Government Relations Manager
Theodore Roosevelt Conservation Partnership

Heather Hulton VanTassel
Executive Director
Three Rivers Waterkeeper

Steven Paulsrud
Board Member, member Action Committee
Upper Mississippi River Region League of women Voters ILO

Roishetta Ozane
Director
Vessel Project of Louisiana

Bart Mihailovich
Director, Waterkeeper Membership Services
Waterkeeper Alliance

Robin Broder
Deputy Director
Waterkeepers Chesapeake

Wynnie-Fred Victor Hinds
Executive Director
Weequahic Park Association

Na'Taki Osborne Jelks
Co-Founder and Executive Director
West Atlanta Watershed Alliance

Debra Buffkin
Executive Director
Winyah Rivers Alliance

cc: Brenda Mallory, Chairperson, CEQ
Martha Williams, Director, USFWS
Bruno Pigott, Acting Assistant Administrator for Water, EPA
Brian Frazer, Director, Office of Wetlands, Oceans and Watersheds, EPA
Michael Connor, Assistant Secretary of the Army for Civil Works
Lieutenant General Scott A. Spellmon, Chief of Engineers, USACE
YazooBackwater@usace.army.mil

From: Mastrototaro, Jill <Jill.Mastrototaro@audubon.org>
Sent: Tuesday, August 27, 2024 1:12 PM
To: YazooBackwater MVK
Cc: Moore, Brian
Subject: [WARNING: UNSCANNABLE EXTRACTION FAILED][Non-DoD Source] (2 of 2) Audubon submittal on Yazoo Backwater DEIS
Attachments: 2024 Audubon_2of2_Delivering Additional Supporters Comments on Yazoo Pumps DEIS_ 8-27-24.pdf; 2024 Audubon Supporters_Yazoo Pumps Comments_CivicShout_8-27-24.xlsx

Good Afternoon:

Audubon is submitting this second attached letter and enclosure for inclusion in the Army Corps' official public record for the Yazoo Backwater Study Area Draft Environmental Impact Statement.

In attached, we present 9,284 comments made by Audubon supporters that have not been provided to the Army Corps until today.

Please acknowledge receipt of this email.

Thank you,
Jill

Jill Mastrototaro
Mississippi Policy Director
504.481.3659

Audubon Delta
PO Box 2026
Ridgeland, MS 39158

Audubon

Audubon DELTA

August 27, 2024

Delivered by Electronic Mail to: YazooBackwater@usace.army.mil

Colonel Jeremiah A. Gipson
Vicksburg District Commander
U.S. Army Corps of Engineers, CEMVK-PPMD
4155 Clay Street
Vicksburg, MS 39183-3435

Mike Renacker
Vicksburg District
U.S. Army Corps of Engineers, CEMVK-PPMD
4155 Clay Street
Vicksburg, MS 39183-3435

Re: Copy of Comments Sent by Audubon Supporters on Yazoo Backwater Study Area Draft Environmental Impact Statement, June 28, 2024

Dear Colonel Gipson and Mr. Renacker,

On behalf of the National Audubon Society, including our regional office, Audubon Delta, we present the 32,091 individually submitted comments (enclosed) that Audubon supporters sent to YazooBackwater@usace.army.mil in response to the U.S. Army Corps of Engineers' (Corps) Yazoo Backwater Study Area Draft Environmental Impact Statement, June 28, 2024.

Audubon wanted to provide the Corps with a full catalogue of the comments submitted through our electronic action alert system during the public comment period that ends today, August 27, 2024. The enclosed spreadsheet with three tabs has a combined total of 32,091 individually submitted comments; 2,842 personalized comments and 29,249 sign on comments. Any duplicate comments or any comments that contained inappropriate language that the Corps received have been removed from these lists.

If you have any questions about the comments, prefer to receive them in a different format, or need additional information about the individuals who submitted comments, please contact Jill Mastrototaro at jill.mastrototaro@audubon.org or (504) 481-3659.

Thank you for ensuring that these comments are considered.

Sincerely,

Brian Moore
Vice-President, Coast Policy, **National Audubon Society**
Acting Executive Director, **Audubon Delta**
Brian.Moore@audubon.org

Jill Mastrototaro
Mississippi Policy Director, **Audubon Delta**
Jill.Mastrototaro@audubon.org

Enclosed

From: Mastrototaro, Jill <Jill.Mastrototaro@audubon.org>
Sent: Tuesday, August 27, 2024 1:09 PM
To: YazooBackwater MVK
Cc: Moore, Brian
Subject: [WARNING: UNSCANNABLE EXTRACTION FAILED][Non-DoD Source] (1 of 2) Audubon submittal on Yazoo Backwater DEIS
Attachments: 2024 Audubon_1of2_Copy of Supporters Comments on Yazoo Pumps DEIS_8-27-24.pdf; 2024 Audubon Supporters_Copy of Yazoo Pumps Comments_8-27-24.xlsx

Good Afternoon:

Audubon is submitting the attached letter and enclosure for inclusion in the Army Corps' official public record for the Yazoo Backwater Study Area Draft Environmental Impact Statement.

In attached, Audubon provides the Army Corps with a full catalogue of the 32,091 comments that were submitted through our electronic action alert system.

Please acknowledge receipt of this email.

Thank you,
Jill

Jill Mastrototaro
Mississippi Policy Director
504.481.3659

Audubon Delta
PO Box 2026
Ridgeland, MS 39158

August 27, 2024

Delivered by Electronic Mail to: YazooBackwater@usace.army.mil

Colonel Jeremiah A. Gipson
Vicksburg District Commander
U.S. Army Corps of Engineers, CEMVK-PPMD
4155 Clay Street
Vicksburg, MS 39183-3435

Mike Renacker
Vicksburg District
U.S. Army Corps of Engineers, CEMVK-PPMD
4155 Clay Street
Vicksburg, MS 39183-3435

Re: Delivering Supporters' Comments on Yazoo Backwater Study Area Draft Environmental Impact Statement, June 28, 2024

Dear Colonel Gipson and Mr. Renacker,

On behalf of the National Audubon Society, including our regional office, Audubon Delta, we present 9,284 comments of Audubon supporters on the U.S. Army Corps of Engineers' (Corps) Yazoo Backwater Study Area Draft Environmental Impact Statement, June 28, 2024 (enclosed).

Since the Corps has not been provided these comments until today, they should now be included in the official record of the public comment period that ends today, August 27, 2024. To reiterate, the enclosed spreadsheet is separate and apart from our submittal that provided a copy of 28,290 individually submitted comments that Audubon supporters sent to YazooBackwater@usace.army.mil.

If you have any questions about the comments, prefer to receive them in a different format, or need additional information about the individuals who submitted comments, please contact Jill Mastrototaro at jill.mastrototaro@audubon.org or (504) 481-3659.

Thank you for ensuring that these comments are considered.

Sincerely,

Brian Moore
Vice-President, Coast Policy, **National Audubon Society**
Acting Executive Director, **Audubon Delta**
Brian.Moore@audubon.org

Jill Mastrototaro
Mississippi Policy Director, **Audubon Delta**
Jill.Mastrototaro@audubon.org

Enclosed

From: Joshua Sewell <Josh@taxpayer.net>
Sent: Tuesday, August 27, 2024 2:47 PM
To: YazooBackwater MVK
Cc: Joshua Sewell
Subject: [Non-DoD Source] Yazoo Backwater EIS comments
Attachments: Yazoo Pump EIS_TCS_Final.pdf

Please see the attached Taxpayers for Common Sense letter commenting on the Yazoo Backwater Area Management Project.

Thank you,

____
Joshua Sewell
Director of Research & Policy

Taxpayers for Common Sense
202-744-3853 (cell)
651 Pennsylvania Ave SE
Washington, DC 20003

TAXPAYERS for COMMON SENSE

August 27, 2024

The Honorable Michael Conner
Assistant Secretary of the Army (Civil Works)
U.S. Army Corps of Engineers
Department of Defense
108 Army Pentagon
Washington, DC 20310-0108

Colonel Jeremiah A. Gipson
Commander
U.S. Army Corps of Engineers
Vicksburg District
4155 Clay Street
Vicksburg, MS 39183-3435

Subject: Opposing the Yazoo Pumps Project

Dear Assistant Secretary Conner and Colonel Gipson:

I write on behalf of Taxpayers for Common Sense (TCS) to express our vehement opposition to the Yazoo Pumps Project, currently under review through an updated Environmental Impact Statement (EIS). Our opposition is due to the fact this project continues to be fiscally, environmentally, and socially unacceptable for taxpayers.

The draft EIS is currently proposing a 25,000 cfs pumping plant, which would have a pumping capacity 78% larger than the 14,000 cfs pumps prohibited by the longstanding Clean Water Act 404(c) veto of the Yazoo Pumps. Pumps of this size would likely cost federal taxpayers well over $1.4 billion.[1] These pumps would be operated on a schedule driven by the desires of large agricultural producers who are farming mostly marginal lands that have always and already receive substantial federal subsidies. We believe that such a sizable investment of taxpayer money must be justified by broad public benefit, which this project clearly lacks. A point we believe your agency implicitly agrees with, as you have chosen not to undertake an updated Economic Analysis to determine what would clearly produce a low Benefit-Cost Assessment.

The potential environmental repercussions are equally troubling. A pumping plant of this size would unquestionably drain and damage 89,800 to more than 93,300 acres[2] of vital wetlands, including thousands of acres that the federal taxpayers have already paid to protect. This flagrant

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[1] The West Closure Complex in New Orleans is currently the world's largest pump station, with a pumping capacity of 19,000 cfs powered by 5,000 horsepower diesel engines. The West Closure Complex cost $1.1 billion in 2014. New Orleans Times Picayune, The West Closure Complex: How it works (updated July 18, 2019); NOLA.com, Photos: Largest pump station in the world, located 30 minutes from New Orleans, gets ready for hurricane season (May 12, 2022).

[2] The Corps has identified two identical preliminary preferred alternatives (Alternatives 2 and 3) except for operating plans that differ by just 9 days. The Corps has proposed compensatory mitigation of just 5,722 to 7,650 acres, depending on the operating plan selected. U.S. Army Corps of Engineers, Draft Environmental Impact Statement for the Yazoo Backwater Area Water Management Project (July 2024) at 38, Wetland Appendix at 34.

disregard for environmental concerns not only undermines the $100 million already invested by taxpayers in these conservation lands but also stands in contradiction to the Clean Water Act.[3]

We are also alarmed by the social and environmental justice implications of the Yazoo Pumps Project. The potential negative impact on predominantly Black communities in North Vicksburg and other downstream locations is unacceptable. Dozens of Black community members and leaders, such as Ty Pinkins of the Pyramid Project and representatives from the Education, Economics, Environmental, Climate & Health Organization (EEECHO), have repeatedly voiced strong opposition to the Yazoo Pumps as an environmental injustice designed to serve wealthy farm owners at the expense of marginalized communities.

Our analysis highlights the disproportionate benefits accruing to large agricultural producers, primarily white, who already receive significant farm subsidies. Indeed, the top 5 recipients in each YBWA zip code receive an average of $215,000 annually for the last 25 years, exacerbating economic inequalities in a region where many households earn less than $15,000 and substantial portions of the population live in poverty.

We urge you to abandon the Yazoo Pumps once and for all. In its place, you should explore the many viable options for reducing flood damages through nonstructural and natural and nature-based measures, including enrolling lands in the Wetland Reserve Easement Program (WRE) and Conservation Reserve Program (CRP), which offer more cost-effective and environmentally friendly solutions to the region's flooding issues. Multiple organizations have proposed a suite of environmentally sound, equitable, and taxpayer friendly solutions that could and should be implemented.

The Yazoo Pumps Project is neither fiscally responsible nor environmentally sound and raises alarming social and environmental justice concerns. For these reasons, we firmly oppose any efforts to move forward with this project and urge you to seek alternatives that are more aligned with the public interest.

We appreciate the opportunity to comment on this critical issue. Should you have any questions or require further information, please feel free to contact us.

Sincerely,

Steve Ellis
President
Taxpayers for Common Sense

---

[3] American Rivers. "Mapping Out an Argument for Stopping the Yazoo Pumps." American Rivers, April 2018, https://www.americanrivers.org/2018/04/mapping-out-an-argument-for-stopping-the-yazoo-pumps/.

From: Ty Pinkins <ty@typinkins.com>
Sent: Monday, August 26, 2024 11:26 AM
To: michael.l.connor10.civ@army.mil; YazooBackwater MVK
Cc: jaime.a.pinkham.civ@army.mil; chelsea.a.haynes4.civ@army.mil; Colosimo, Robyn S SES USARMY HQDA ASA CW (USA)
Subject: [Non-DoD Source] Community Letter on Yazoo Backwater Area Draft Study Process
Attachments: Community Sign-On Letter.pdf

Dear Assistant Secretary Connor and Colonel Gipson,

Please see the attached letter from 56 community members from Mississippi's Yazoo Backwater Area urging the U.S. Army Corps of Engineers to abandon the Yazoo Pumps and instead to work to quickly implement nature-based and nonstructural solutions.

Thank you in advance for acknowledging receipt of this email as part of your Draft Study process.

Sincerely,

Ty Pinkins
Founder and President, The Pyramid Project

THE PYRAMID PROJECT

August 26, 2024

The Honorable Michael Regan
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, N.W.
Washington, DC 20460

The Honorable Michael Connor
Assistant Secretary of the Army (Civil Works)
108 Army Pentagon (3E446)
Washington, DC 20310-0108

Re: My Community Deserves 21st-Century Flood Solutions Not the Phony Yazoo Pumps

Dear Administrator Regan and Assistant Secretary Connor,

As a proud son of the Mississippi Delta, I fight every day to ensure communities across the region get the justice, equality, and resources they need and deserve—whether it's the daily struggle to make ends meet, in breaking through systemic racial injustice, or recovering from the 2023 tornado tragedy that wiped my hometown of Rolling Fork off the map.

So it is with great urgency that I write to you once again to call out your agencies' unacceptable and offensive pursuit of the Yazoo Backwater Pumps, a project that is a slap in the face to Black community members of the Yazoo Backwater Area. Your agencies' deliberate decision casts aside the honest requests many other minority community members and I have made in asking you to disavow the Yazoo Pumps and put your energies into providing effective 21st-century flood relief programs and environmental justice resources, especially through nonstructural and nature-based approaches.

Community members like me are not fooled by the false claims that the Yazoo Pumps are the only solution to protect us from flooding. In fact, your latest plan to operate the Pumps around planting seasons lays bare what we have known all along—that this project is little more than a corporate giveaway that helps large farm owners plant more crops on low-lying farms. Building the Pumps will spend more than a billion of our tax dollars so rich farm owners can get even richer while our communities remain vulnerable to flooding in the face of structural inequity and tornado recovery.

To add further insult, your Pumps plan now shockingly proposes forced removal of Black community members' homes and property through "mandatory" acquisition under the guise of "environmental justice"—an obscene perversion that could not be further from the truth. Not only does this reprehensible proposal further reinforce that the Pumps are designed to benefit wealthy white farmers, it perpetuates the oppressive burdens my fellow Black community members, generations of my family, and I have faced and work so hard to overcome. This is eminent domain pure and simple.

All of this on top of the fact that your proposal roundly ignores the repeated requests from many low-income and minority residents from the Yazoo Backwater Area for swift help in delivering 21st-century flood mitigation programs and funding, especially through effective nonstructural and nature-based flood relief tools. My work with disadvantaged communities in the Yazoo backwater to secure non-financial technical assistance through the FEMA BRIC program demonstrates their desire for these effective flood relief solutions—solutions that are available and funded and could quickly be put to work to benefit people's lives and property while helping to address many fundamental hardships.

I call on you to take the Yazoo Pumps and their false promise of flood relief off the table once and for all, and to immediately work to put nonstructural and nature-based flood solutions in place that can help vulnerable Yazoo backwater communities.

Sincerely,

Ty Pinkins
Founder & President
The Pyramid Project, Sharkey County

From:	Ty Pinkins
To:	michael.l.connor10.civ@army.mil; YazooBackwater MVK
Cc:	jaime.a.pinkham.civ@army.mil; chelsea.a.haynes4.civ@army.mil; Colosimo, Robyn S SES USARMY HQDA ASA CW (USA)
Subject:	[Non-DoD Source] Community Letter on Yazoo Backwater Area Draft Study Process
Date:	Monday, August 26, 2024 11:28:19 AM
Attachments:	Community Sign-On Letter.pdf

Dear Assistant Secretary Connor and Colonel Gipson,

Please see the attached letter from 56 community members from Mississippi's Yazoo Backwater Area urging the U.S. Army Corps of Engineers to abandon the Yazoo Pumps and instead to work to quickly implement nature-based and nonstructural solutions.

Thank you in advance for acknowledging receipt of this email as part of your Draft Study process.

Sincerely,

Ty Pinkins
Founder and President, The Pyramid Project

August 26, 2024

The Honorable Michael Connor
Assistant Secretary of the Army (Civil Works)
U.S. Army Corps of Engineers
108 Army Pentagon (3E446)
Washington, DC 20310-0108
michael.l.connor10.civ@army.mil

Colonel Jeremiah A. Gipson
Vicksburg District Commander
U.S. Army Corps of Engineers
4155 Clay Street
Vicksburg, MS 39183-3435
YazooBackwater@usace.army.mil

Re: Community Letter on Yazoo Backwater Area Draft Study Process

Dear Assistant Secretary Connor and Colonel Gipson,

The 56 undersigned community members, homeowners, and landowners from Sharkey and Issaquena Counties write to express our continued opposition and outrage to the U.S. Army Corps of Engineers' (Corps) latest plan for the Yazoo Backwater Area. We will not let you ignore our voices.

As we have told the Corps over and over again: We want effective flood relief through nonstructural and nature-based solutions that honors and respects our underserved communities—not the false promise of the Yazoo Pumps.

On top of pushing another sham version of the Yazoo Pumps onto our communities, you now propose to take our homes and property through eminent domain and condemnation under the shameful perversion of environmental justice. This is not flood relief, this is a violation of the generational struggles our Black communities have endured in rising up against abuse, poverty, and injustice. The legacy of our communities and our families will not be sacrificed to feed the desire of affluent farm owners.

Time after time, we have urged you to abandon any version of the Yazoo Pumps because we know the real truth—the Pumps will not keep our communities from flooding. The Pumps are all about enriching large farm owners by helping them plant more crops on low-lying lands while our genuine needs and requests continue to be dismissed. It is an affront to the legitimate health, safety, and recovery needs of our communities that your plan to operate the Pumps is entirely driven to benefit wealthy agricultural interests. This plan is even more appalling in the face of our continued struggle to recover from the devastating 2023 tornado and the daily hardships of persistent racial and environmental injustice.

Once again, we call on you to abandon this and any version of the Yazoo Pumps and to instead work with the Environmental Protection Agency, U.S. Department of Agriculture, and others to quickly implement nature-based and nonstructural solutions that can help us recover and thrive. These solutions include elevating and flood-proofing homes, businesses and roads protecting targeted areas with floodplain easements; and engaging with Yazoo backwater farm owners to expand conservation easements and related wetland restoration, which would provide additional flood protection for our communities. Targeted, voluntary relocations and buy-outs should also be pursued if willing community members can be given enough money to allow them to relocate to areas that will be flood free.

We call on you to begin to address the substantial needs of our low-income, minority communities by investing the hundreds of millions of our tax dollars needed to build the phony Pumps into these vital programs. Our communities deserve respect, action, and compassion, not yet another false promise of being saved by the Yazoo Pumps while our homes and businesses are stripped from us.

Please reach out to Ty Pinkins at ty@typinkins.com if you have any questions.

Sincerely,

Ty Pinkins
Founder & President
The Pyramid Project, Sharkey County

Roy Rucker
CEO
Tardigrade Communications, Sharkey County

Jessica Berdley
Homeowner, Sharkey County

Herbert Brown
Homeowner, Sharkey County

Leon Brown
Homeowner, Sharkey County

Tonyika Bryant
Homeowner, Sharkey County

Sallie Burden
Homeowner, Sharkey County

Shawonder Harris
Homeowner, Sharkey County

Denisha Jackson
Homeowner, Sharkey County

Freddie Jackson
Homeowner, Sharkey County

Robert Jackson
Homeowner, Sharkey County

Rodney Jackson
Homeowner, Sharkey County

Rosie Jackson
Homeowner, Sharkey County

Willie Jackson
Homeowner, Sharkey County

Cornell Knight
Homeowner, Sharkey County

Sylvester Pinkins
Homeowner, Sharkey County

Felicia Brown
Landowner, Sharkey County

Darlene Brown
Landowner, Sharkey County

Luella Brown
Landowner, Sharkey County

Troy Brown
Landowner, Sharkey County

Vanaleen Dennis
Landowner, Sharkey County

Larry Diggs
Landowner, Issaquena County

Michael Franklin
Landowner, Sharkey County

Michaela Franklin
Landowner, Sharkey County

Claretta Hite
Landowner, Sharkey County

James Hite
Landowner, Sharkey County

Suprina Hite
Landowner, Sharkey County

Alfred Jackson
Landowner, Sharkey County

Don Jackson
Landowner, Issaquena County

Juanita Jackson
Landowner, Sharkey County

Monica Jackson
Landowner, Sharkey County

Quintavius Jackson
Landowner, Sharkey County

Hattie Lewis
Landowner, Issaquena County

Robert Lewis
Landowner, Issaquena County

Patricia Mason
Landowner, Issaquena County

Patricia Pinkins
Landowner, Sharkey County

Regina Pinkins
Landowner, Sharkey County

DeBorah Williams
Landowner, Issaquena County

Tonya Battee
Community Member, Sharkey County

Sentha Bullock
Community Member, Sharkey County

Henry Burden
Community Member, Sharkey County

Sonya Burden
Community Member, Sharkey County

Tonya Burden
Community Member, Sharkey County

Samantha Gordon-Pinkins
Community Member, Sharkey County

Roshunda Harris
Community Member, Sharkey County

Danika Hite
Community Member, Sharkey County

Jermaine Hite
Community Member, Sharkey County

Quanta Hite
Community Member, Sharkey County

Tiffany Hite
Community Member, Sharkey County

Antwan Jackson
Community Member, Sharkey County

Christian Jackson
Community Member, Sharkey County

Nathaniel Jackson
Community Member, Sharkey County

Rodney Ousley
Community Member, Sharkey County

Travis Pinkins
Community Member, Sharkey County

Willie Pinkins
Community Member, Sharkey County

Peggy Thomas
Community Member, Issaquena County

From: Michelle Montoya <michelle.montoya@environmentalprotectionnetwork.org>
Sent: Friday, August 16, 2024 12:09 PM
To: Regan.Michael@epa.gov
Cc: Gettle.Jeaneanne@epa.gov; Frazer, Brian HQ02; Pigott.Bruno@epa.gov; Prieto.Jeffrey@epa.gov; Spellmon, Scott A LTG USARMY CEHQ (USA); michael.l.connor.civ@mail.mil; YazooBackwater MVK; Jamie Zwaschka; Michelle Roos
Subject: [Non-DoD Source] Yazoo River Backwater Pumps
Attachments: EPN Letter on Yazoo 2024 Proposed Plan.pdf

Dear Administrator Regan,

Attached please find a letter from the Environmental Protection Network (EPN), an organization of over 650 U.S. Environmental Protection Agency (EPA) alumni volunteering their time to protect the integrity of EPA, public health, and the environment. The letter, written by several of our volunteers who were actively involved in the development of the 2008 Section 404(c) Final Determination for the Yazoo River Backwater Pumps, outlines EPN's concerns with the potential adverse impacts of the U.S. Army Corps of Engineers' (ACOE's) recently-proposed project to address flooding in the Yazoo Backwater region.

EPN believes that the 2008 Final Determination clearly prohibits discharges for the purpose of construction and operation of the proposed pump "or any similar pump project" within the defined project area that would result in similar or adverse impacts to jurisdictional wetlands and other waters of the United States. Similar to concerns EPA identified in the 2008 Final Determination and EPN expressed on earlier versions of the pumping project, EPN's concerns with the potential adverse impacts of this version of the project remain.

If ACOE remains committed to moving forward with this version of the project, the ACOE should follow the long-standing approach to modify a CWA Section 404(c) final agency action by making a formal request to EPA.

Thank you for your attention to this matter and for your continued work to protect public health and the environment.

If you have any questions or if we can provide any further information, please contact us.

Sincerely,

Michelle Montoya (*she/her*)
Policy Director
michelle.montoya@environmentalprotectionnetwork.org
Cell: 917.509.3613
www.environmentalprotectionnetwork.org

Environmental Protection Network

(202) 656-6229
environmentalprotectionnetwork.org
info@environmentalprotectionnetwork.org

August 16, 2024

The Honorable Michael S. Regan
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue NW
Washington, D.C. 20004

RE: Yazoo River Backwater Pumps 2008 Clean Water Act Section 404(c) Final Determination; 2024 Draft Environmental Impact Statement

Dear Administrator Regan:

The Environmental Protection Network (EPN) is an organization of over 650 U.S. Environmental Protection Agency (EPA) alumni volunteering their time to protect the integrity of EPA, public health, and the environment. EPN harnesses the expertise of former EPA career staff and confirmation-level appointees from Democratic and Republican administrations to provide the unique perspective of former regulators with decades of historical knowledge and subject matter expertise. Several of our volunteers were actively involved in the development of the 2008 Section 404(c) Final Determination for the Yazoo River Backwater Pumps[1] and helped write this letter.

On June 28, 2024, the Army Corps of Engineers (ACOE) issued a draft Environmental Impact Statement (EIS) that includes a modified plan to address flooding in the Yazoo Backwater Area. This plan (the 2024 proposed plan) includes large pumps adjacent to the Steele Bayou structure to remove water from the backwater area that could potentially drain and impact up to 97,000 acres of wetlands, including wetlands identified in the 2008 Clean Water Act (CWA) Section 404(c) Final Determination (2008 Final Determination). The 2024 proposed plan includes a proposal to fully develop a pump operating regime, limited proposed mitigation, and limited structural alternatives. The 2024 proposed plan has the same or similar impacts as the plan that was identified and prohibited in the 2008 Final Determination. It also has similar impacts as the 2020 proposed plan which EPA later found were also prohibited under the 2008 Final Determination. As discussed below, consistent with our position in 2020, EPN is focused on the fact that the 2024 proposed plan is prohibited by the 2008 Final Determination. In addition, if ACOE would like to seek to modify the 2008 Final Determination, it has not taken the appropriate steps.

<u>Background</u>

In 2008, EPA issued a Final Determination under Section 404(c) of the CWA withdrawing the specification of the proposed project site for the discharge of dredged and/or fill material for the construction of the project. EPA determined that "the construction and operation of the proposed pumps would dramatically alter the timing, and reduce the spatial extent, depth, frequency, and duration of time that wetlands within the project area are inundated." Furthermore, "these large-scale hydrologic alterations would significantly

[1] Final Determination of the U.S. Environmental Protection Agency's Assistant Administrator for Water Pursuant to Section 404(c) of the Clean Water Act Concerning the Proposed Yazoo Backwater Area Pumps Project Issaquena County, Mississippi. August 31, 2008. https://www.epa.gov/sites/default/files/2015-05/documents/yazoo-final-determination_signed_8-31-08.pdf

degrade the critical ecological functions provided by approximately 67,000 acres of wetlands in the Yazoo Backwater Area, including those functions that support wildlife and fisheries resources."[2] These impacts were not tied to the particular footprint/precise location of the proposed pump but rather to their operation and purpose.

Significant portions of the area that would have been impacted are currently in national wildlife refuges, national forest lands, lands enrolled in federal conservation programs, and state-owned conservation lands. In addition, some of the lands have been purchased and restored using taxpayer funds as mitigation for previously constructed federal water projects.

The implementing regulations for Section 404(c) of the CWA, 40 CFR Part 231, set out a very specific and mandatory process to issue Section 404(c) Final Determinations. During the 2008 Section 404(c) process, EPA met with local stakeholders, held a formal public hearing, issued and published draft and recommended determinations that allowed for public comment, and responded to all comments made and/or submitted related to the project. This process allowed for a full vetting of all the relevant issues, including the environmental impacts of the project as well as environmental justice concerns.

The scope of the 2008 EPA Section 404(c) review included all the alternatives presented by ACOE in the National Environmental Policy Act (NEPA) documents that supported the project, including Plans 3, 4, 5, 6, 7, and a modified Plan 6. During its review and in the Final Determination, EPA found all six of the plans resulted in unacceptable adverse effects to wetlands and fish and wildlife resources (including spawning and breeding areas), the trigger for action under Section 404(c). Ultimately, in 2008, ACOE chose Plan 5 as the Least Environmentally Damaging Practicable Alternative (LEPDA), which became the subject of the Section 404(c) Final Determination.

On January 15, 2021, ACOE published its Record of Decision (ROD) for the Yazoo Area Pumps Project. The ROD was based on the Final Supplemental EIS No. 2, which was finalized on December 11, 2020, with a 45-day public comment period. On November 30, 2020, the then Regional Administrator for EPA Region 4 concluded that the proposed project was *not* prohibited by EPA's 2008 Final Determination.[3] This conclusion was challenged in court and resulted in a remand from the court back to EPA for reconsideration.

EPN submitted comments[4] on October 15, 2021, noting that EPN believed the Regional Administrator at that time erroneously concluded that the proposed 2020-21 pump project was not covered by the 2008 Final Determination. The decision had been made without the opportunity for public input and importantly did not follow precedent for modifying a CWA Section 404(c) Final Determination. As a result, many of the issues the public commented on and the EPA reviewed as part of the 2008 Final

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[2] Final Determination of the U.S. Environmental Protection Agency's Assistant Administrator for Water Pursuant to Section 404(c) of the Clean Water Act Concerning the Proposed Yazoo Backwater Area Pumps Project Issaquena County, Mississippi. August 31, 2008. page i.

[3] November 30, 2020 letter from Mary S. Walker, Regional Administrator, EPA Region 4, to Colonel Robert A. Hilliard, U.S. Army Corps of Engineers, Vicksburg District.

[4] https://www.environmentalprotectionnetwork.org/wp-content/uploads/2021/10/EPN-Letter-on-Yazoo-404c-permit.pdf

Determination, including an analysis of the environmental justice issues, were not fully discussed nor was there full opportunity for public input on this highly significant federal action.

Subsequently, on November 17, 2021, EPA issued a letter to ACOE, finding that the 2020-21 proposed plan was prohibited by the 2008 Section 404(c) Determination. This led to numerous discussions among the agencies and on January 9, 2023, EPA and ACOE signed a joint collaboration memorandum to work towards identifying an approach to reduce flood risk in the Yazoo Backwater Area.[5]

Discussion

Following the collaborative process, on June 28, 2024, ACOE issued a Draft EIS identifying a "new" pumping project with a 45-day public comment period initially ending on August 12, 2024, but extended to August 27, 2024. Although this plan does include some "mandatory buy-outs"of 52 homes in economically-disadvantaged communities in the Yazoo Backwater Area, it also includes a substantial pump that has the potential to drain the same or similar wetlands identified in the 2008 Section 404(c) Determination and potentially more. EPN believes that, similar to our earlier position on the 2020 version of the project, this proposed project would not be allowed under the 2008 Final Determination unless that Determination is modified following practices EPA had established in prior actions.

It is important to note that the 2008 Final Determination anticipated and prohibited any similar pump projects located within the Yazoo Backwater Area identified in the Final Determination that would have the same or similar adverse impacts within the project area. Simply moving the location of the pumps upstream within the same defined project area, changing the fuel used by the pumps, changing the size of the pumps, or changing pump operation parameters does not significantly alter the project impacts or its purpose. In the 2008 Final Determination, EPA noted that "derivatives of the prohibited projects that involve only small modifications to the operational features or location of these proposals would also likely result in unacceptable adverse effects and would generate a similar level of concern and review by EPA."[6] This language indicated that "derivatives" and "changes in location" were presumptively covered by the Final Determination, because of the likelihood they would have similar impacts, but that EPA would review such impacts if such changes were proposed.

Precedents for Modifying a 404(c) Final Determination

In order to modify the project, we believe ACOE should seek modification of the 2008 Final Determination issued by EPA. In an August 22, 2019 letter from the Regional Administrator to ACOE, EPA informed ACOE in writing about the detailed information ACOE would need to submit to EPA along with a formal request before the agency would review the 2008 Final Determination.[7]

Section 404(c) and the implementing regulations in 40 CFR Part 231 specifically note that a Final Determination issued by the EPA Administrator under Section 404(c) is a final agency action that is then

[5] Joint Memorandum of Collaboration Between the U.S. Department of the Army (Civil Works) and U.S. Environmental Protection Agency, January 9, 2023.

[6] Final Determination of the U.S. Environmental Protection Agency's Assistant Administrator for Water Pursuant to Section 404(c) of the Clean Water Act Concerning the Proposed Yazoo Backwater Area Pumps Project Issaquena County, Mississippi. August 31, 2008. page iv.

[7] August 22, 2019 letter from Mary S. Walker, Regional Administrator, EPA Region 4, to Major General R. Mark Toy.

subject to review in the courts. Absent court review, the path for ACOE to take to modify the project is to use the applicable Section 404(c) procedures.

During the history of the Section 404(c) program, EPA has issued 14 Final Determinations. EPA has directly modified only two of the issued Final Determinations to address changed circumstances or different needs. In both cases, EPA went through the appropriate public process identified in the implementing regulations, after a specific detailed request from ACOE to modify the Section 404(c) Final Determination. This included the issuance of a public notice, the review and response to public comments, and the issuance of an amendment to the Final Determination. In both prior cases, the project changes and impacts were minor. However, although the 2020-21 Yazoo Pump project changes from the 2008 project were relatively minor, the overall project impacts are still major. The same applies to the 2024 proposed plan.

By not following this process we believe EPA and ACOE did not fully consider the complex set of concerns voiced by stakeholders directly and indirectly affected by the project, including serious environmental justice concerns.

Conclusion

EPN believes that the 2008 Final Determination clearly prohibits discharges for the purpose of construction and operation of the proposed pump "or any similar pump project" within the defined project area that would result in similar or adverse impacts to jurisdictional wetlands and other waters of the United States. Similar to concerns EPA identified in the 2008 Final Determination and EPN expressed on earlier versions of the pumping project, EPN's concerns with the potential adverse impacts of this version of the project remain.

However, if ACOE remains committed to moving forward with this version of the project, the ACOE should follow the long-standing approach to modify a CWA Section 404(c) final agency action by making a formal request to EPA. As noted above, EPA previously outlined the necessary information that should be submitted.[8]

This letter was prepared by EPA alumni and EPN volunteers Philip Mancusi-Ungaro and James Giattina. If you have any questions or if we can provide any further information, please contact us.

Sincerely,

Michelle Roos
Executive Director
Environmental Protection Network

[8] August 22, 2019 letter from Mary S. Walker, Regional Administrator, EPA Region 4, to Major General R. Mark Toy.

cc: Michael Connor
Assistant Secretary of the Army for Civil Works

Lieutenant General Scott A. Spellmon
Chief of Engineers, ACOE

Bruno Pigott
Acting Assistant Administrator for Water, EPA

Brian Frazer
Director, Office of Wetlands, Oceans and Watersheds, EPA

Jeaneanne Gettle
Acting Regional Administrator, EPA Region 4

Jeffrey Prieto
Acting General Counsel, EPA

YazooBackwater@usace.army.mil

From: Jim Steitz <jimsteitz@mac.com>
Sent: Friday, August 2, 2024 1:21 AM
To: YazooBackwater MVK
Subject: [Non-DoD Source] Withdraw Yazoo Area Pumps Project

Follow Up Flag: Follow up
Flag Status: Flagged

Jim Steitz

5330A Jamieson Avenue

St. Louis, MO 63109

August 2, 2024

ATTN: CEMVK-PPMD

Vicksburg District, U.S. Army Corps of Engineers

4155 East Clay Street

Vicksburg, MI 39183

Dear Army Corps of Engineers,

I urge you to withdraw your effort to revive the environmentally catastrophic, grotesquely wasteful 'Yazoo Area Pumps Project' in Mississippi. No amount of NEPA hand waving can alter the dispositive, fatal errors of both fact and morality in the conceptual premises of the Yazoo Project. This project has lingered as a pet dream of major agricultural interests in Mississippi for decades, has been rightly and repeatedly rejected by the Army Corps and Engineers and the Environmental Protection Agency, including under the Bush Administration, because it would drain and eradicate 200,000 acres of the country's most precious wetlands in the watershed of Mississippi's Big Sunflower River. No facts have changed to warrant the Corps' attempt to evade or suborn this veto.

Rather than accept the implication of this fact, the Corps now seeks to subvert and disappear the long-established Clean Water Act review process for federal projects, nullify the considered judgment of agency scientists, and impose this gross caricature of home-state pork through raw political power. This represents an **explicit demand for the liquidation of one of America's irreplaceable biological Edens, in exchange for barren, vacant land to produce low-value**

commodity crops. 200,000 acres of swamps, bayous, marshes, and bottomland forests will vanish, making a blatant mockery of repeated American commitments to staunch the loss of our wetlands. **A more profane theft against our children and our Planet Earth, for the most venal, parochial, selfish of reasons could not be fathomed.**

The Environmental Protection Agency vetoed the Yazoo project in 2008, owing to the outlandish and gratuitous ecological destruction it would cause, and the utter lack of any public interest in constructing one of the world's largest water pumping complexes in a sparsely populated region. **The Yazoo pumps would constitute a $300 million engineering subsidy to help landowners violently remake the landscape of Mississippi to their agricultural convenience**. The pumps' sole purpose is to move up to six gallons of water per minute from one side to another of a Corps' flood control structure, to **assist a handful of large landowners to increase production on lands that naturally, regularly flood and are inappropriate for agriculture**. This area already receives several million dollars federal subsidies annually, the highest payouts in Mississippi, due to regular flooding.

The Yazoo pumps represent a resurrection of a bygone era in hydrological engineering, deploying overwhelming force against the natural cycles, contours, and dynamics of the Earth's life support system. **The wetlands that will cease to exist include jewels of the Delta National Forest and four National Wildlife Refuges in Mississippi**, which the American people have invested dearly to protect for decades. More than 450 species of fish and wildlife, including 257 species of birds, rely on the wetlands to be drained by the Yazoo pumps. The public interest in maintaining these wetlands, and the right of the plants and animals to retain their homes in these wetlands, supersedes the avaricious, petty interests of agricultural interests in claiming a publicly subsidized production zone. These verdant, vibrant remnants of America's biological heritage defy any financial tabulation, and to **deny our children the Big Sunflower River wetlands, as their rightful inheritance, would be a moral crime beyond any redemption for the Corps.** It would serve no purpose but to surrender more fragile floodplains to production of more of the commodity crops from which America is already suffering a gross overproduction, and for which USDA already pays millions to render economically viable.

Rather than spend $300 million on crude, brittle, sprawling water engineering that would be only marginally effective by the Corps' own admission, **the federal government could compensate agricultural landowners by a similar amount to fallow their inappropriately located cultivation, and allow this flood-prone land to return to marshes and forests**. This would fully eliminate financial risk for the relevant farmers, immensely benefit the wetland ecosystem species that have already lost so much Mississippi River wetlands, and restore wetland functions of absorption and storage that will mitigate risk to remaining landowners. The superiority of a natural restoration alternative to the Yazoo pumps fiasco is obvious by every metric, and should have concluded the NEPA process years ago.

Again, I urge you **withdraw this effort to resurrect this ecological, moral, and fiscal travesty known as the 'Yazoo Area Pumps Project,' and accept the prior EPA veto**, whose warrant has only increased since 2008, as wetlands have continued to retreat across America before human consumption. The project exemplifies the very worst of parochial engineering on behalf of narrow agricultural interests, rendering the Corps a private engineering service to subsidized floodplain farmers. The selfish, parochial demands of the Mississippi delegation are to be expected from politicians advocating their wealthiest constituents' expropriation of public resources, but **bear no relevance to your consideration of the American public interest.**

Sincerely,

Jim Steitz

From: mandolynmcabee@everyactioncustom.com on behalf of Mandolyn McAbee
To: YazooBackwater MVK
Subject: [Non-DoD Source] Reject the Yazoo Backwater Pump Project
Date: Tuesday, August 27, 2024 6:58:00 PM

Dear Army Colonel Jeremiah Gibson,

I am writing to ask you to protect the vital wetlands in the Yazoo Backwater Area of Mississippi by recognizing the Environmental Protection Agency's long-standing Clean Water Act 404(c) veto protecting this area. The exceptional wetlands in the Backwater Area have been nurtured and restored by federal investment in USDA Farm Bill Programs on private land and through wetland and bottomland hardwood forest restoration projects on public lands: Delta National Forest, Federal Refuges and state wildlife management areas. Much of this work and investment by the USDA NRCS and private funders will be placed at risk from the U.S. Army Corps of Engineers' proposed Yazoo Backwater Pumping plant—an agricultural drainage project being promoted as flood control.

The Corps' 24,000 cubic feet per second capacity pumping facility at Steele Bayou would be larger than any pumps anywhere in the Mississippi River drainage area. The preferred pumping schedule under Alternative 2 would start running the pumps as early as March 15th. There are serious concerns about the effect this would have on migratory birds and on floodplain dependent species of fish that spawn in floodplains during seasonal floods on coastal plain rivers like the Big Sunflower River in the backwater area. De-watering areas of the Yazoo Backwater Area through pumping also lowers water levels and removes late winter and early spring seasonal fish spawning habitat. River dependent fish species exit river channels during seasonal high water and use flooded backwater areas for spawning and rearing of juvenile fish. One of the strongest reasons that EPA gave for their veto of the Yazoo Pump Project in 2008 was to support fish spawning habitat.

I urge you to support non-structural flood risk management methods in the Yazoo Backwater Area instead of pump construction. Nature-based and non-structural flood management should be employed here rather than a pump plan. One of the Corps' main stated purposes for creating a Yazoo Backwater Area flooding solution is to reduce agricultural intensification, but the plans to build pumps will support farmers' crop planting schedules, which only intensifies agriculture.

The Corps is working with conflicting purposes. I ask that the Corps abandons the pump plans, and instead honors the 2008 Clean water act veto of the Yazoo Backwater Pumps.

Sincerely,
Ms. Mandolyn McAbee
8188 Pacific Beach Dr Fort Myers, FL 33966-7954
mandolynmcabee@gmail.com

From:	Rachel Osner (rcosnerht@hotmail.com) Sent You a Personal Message
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Oppose the Ineffective, Destructive Yazoo Pumps and Employ Proven Nature-Based Flood Relief Solutions, CEMVK-PPMD
Date:	Tuesday, August 27, 2024 6:44:42 PM

Dear Colonel Jeremiah A. Gipson,

Dear Colonel Gipson,

I am writing to express my strong opposition to the U.S. Army Corps of Engineers (Corps) renewed effort to build the environmentally devastating agricultural drainage project known as the Yazoo Backwater Pumps.

I ask that you abandon the 2024 plan and eliminate all variations of the Yazoo Pumps once and for all. Instead, I urge the Corps to prioritize effective nature-based and nonstructural flood solutions that truly benefit vulnerable communities and wildlife.

The Yazoo Pumps would be so harmful that the George W. Bush administration vetoed the project in 2008 through the Clean Water Act to protect tens of thousands of acres of nationally important wetlands. It is appalling that the Corps is now proposing a 78% larger Pump that would be the largest hydraulic pump in the world and would drain and damage 90,000 acres of wetlands.

Contrary to the Corps? longstanding claim that the Pumps are the panacea to provide flood protection, your agency?s latest proposal would operate the Pumps based on agricultural planting seasons. This outrageous plan verifies past findings that the Pumps are not designed to protect communities from flooding; rather, 80% of the project benefits come from draining wetlands so agribusiness can make more money.

Further, it?s disturbing that mandatory buyouts through condemnation of residential and commercial properties will be required--most of which are in disadvantaged rural communities. The plan also proposes voluntary buyouts for even more homes and businesses, as well as tens of thousands of acres of farmland.

Communities plagued by flooding in the Mississippi Delta deserve 21st-century safeguards that keep people and property out of harm's way, such as elevating homes and roads and compensating farmers to restore cropland to wetlands. Many local community leaders have asked for these commonsense, nature-based, and nonstructural solutions to benefit people and wildlife. The Corps plan contains none of this.

I urge the Corps to stop its misguided efforts to build this--or any--version of the Yazoo Pumps and, instead, work to advance proven, environmentally sustainable flood risk solutions that will protect local communities and globally important wildlife habitats.

Sincerely,

Rachel Osner
4535 Pike Ave
Sarasota, FL 34233
rcosnerht@hotmail.com
(941) 685-4459

From: Phillip Byrd <pcbyrd@yahoo.com>
Sent: Wednesday, July 17, 2024 6:54 AM
To: YazooBackwater MVK
Subject: [Non-DoD Source] Backwater

When I look at the alternative options and see the pool levels I am very concerned. The pool level at 90 feet is too high when we have big rains the gate or a pump can't keep up. The hunting season pool level at 93 is extremely too high. A lot of hunting land, gravel roads as well as hunting land that we pay high payments on or rent to hunt will be underwater. I recommend to lower these pool levels for all of us. Thank you Phillip Byrd.
Sent from my iPhone

From: Deborah Williams <legacyvillage22@gmail.com>
Sent: Monday, July 22, 2024 7:13 PM
To: YazooBackwater MVK
Subject: [Non-DoD Source] Comment submitted from website for Yazoo Backwater

I am tje daughter of a property owner and relative to the entire lower Fitler area, Low Water Bridge/Goose Lake Road.

1) This area never is featured in the study, why? Since the flooding the two access bridges have been removed in this area, why?

2) Goose Lake Road, home of Taylor family, their natural gas, Atmos lines were removed and not replaced. Ms. Taylor has not been able to return to her family home and no one cares.

3) Every flooding year, these areas floods, where road access is cut off and home owners have to move.

4) Why in this planning no one put actual foot soldiers to knock on doors of residents, where ever they maybe now to ask the questions, what they feel is needed.

5) Sadly, all these meetings, it has accomplished hidden agendas, I feel,

A) To dismiss the low income and small farmers to the point of what I witness today, where very, very few of people of color are in attendence, although they have been the backbone of these generations after generations proud farmers and no one dare recognize or ask the question, where are they?

B) Where in your plan includes those small farmers and owners to benefit from staying or coming back?

Ms. DeBorah Chocolate Williams

662-907-3644 or. 662-873-9424

From: Larson Frey <larsonfrey@gmail.com>
Sent: Monday, August 5, 2024 9:55 AM
To: YazooBackwater MVK
Subject: [Non-DoD Source] Yazoo backwater comments

Thank you for the opportunity to share my thoughts on this issue.

Our farm is located on the Sharkey/Washington County line. Over the years, when we have experienced severe backwater, we have only had high ridges out and had to build up levees around our houses and grain bins. Allowing a pumping station can alleviate this. If we are concerned about pollution, why are we not addressing drainage all other times of the year. The whole system needs to be changed. Weirs in canal ditches, dredging the Big Sunflower, etc.

We've built a system to shoot water quickly into the river. Without an outlet, it's a disaster every time we have high river/excessive rainfall. If a pump isn't going to happen, start at the head of the Big Sunflower and work your way down with weirs on all large ditches, etc to mitigate run off. Dredge the Big Sunflower. Put a weir in the Bogue Phalia. Let the sediment do the work in backfilling these huge ditches to clean up runoff and then let's revisit the pumps with a clean waterway.

Larson Frey

From:	Stanley, Joyce A <Joyce_Stanley@ios.doi.gov>
Sent:	Monday, August 12, 2024 11:22 AM
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Comments and Recommendations on the Draft Environmental Impact Statement for the Yazoo Backwater Area Water Management Project in Mississippi and Louisiana - ER 24-0302
Attachments:	Yazoo Backwater Area Water Management Project - ER 24-0302.pdf

Please see the attached comments from the US Department of the Interior.

Joyce A. Stanley, Ph.D.
Regional Environmental Officer
US Department of the Interior
Office of Environmental Policy and Compliance
South Atlantic-Gulf & Mississippi-Basin
(404) 852-5414 - Mobile (24 hour)
joyce_stanley@ios.doi.gov
http://www.doi.gov/oepc/atlanta.html

United States Department of the Interior

OFFICE OF THE SECRETARY
Office of Environmental Policy and Compliance
100 Alabama Street SW, 1924 Building
Atlanta, GA 30303

August 12, 2024

IN REPLY REFER TO:

ER 24/0302

U.S. Army Corps of Engineers, Vicksburg District
Attention: Mike Renacker
CEMVK-PPMD, Room 248
4155 East Clay Street
Vicksburg, Mississippi 39183

Re: Comments and Recommendations on the Draft Environmental Impact Statement for the Yazoo Backwater Area Water Management Project in Mississippi and Louisiana

Dear Mr. Renacker:

The U.S. Department of the Interior (Department) has reviewed the Draft Environmental Impact Statement (EIS) for the Yazoo Backwater Area Water Management Project in Mississippi and Louisiana. The Department appreciates the opportunity to comment on the project and offers the following comments.

The Department jointly administers the Land and Water Conservation Fund (LWCF) with state agencies and therefore retains authority to advocate on behalf of these resources. Per the LWCF Manual, "Property acquired or developed with LWCF assistance shall be retained and used for public outdoor recreation. Any property so acquired and/or developed shall not be wholly or partly converted to other than public outdoor recreation uses without the approval of National Park Service (NPS) pursuant to the LWCF Act (54 U.S.C. § 200305(f)(3)) and conversion requirements outlined in regulations (36 C.F.R. § 59.3)."

Situations that trigger a conversion include:

a. Property interests are conveyed for private use or non-public outdoor recreation uses.
b. Non-outdoor recreation uses (public or private) are made of the project area or a portion thereof, including those occurring on pre-existing rights-of-way and easements, or by a lessor.

c. Unallowable indoor facilities are developed within the project area without NPS concurrence, such as unauthorized public facilities and sheltering of an outdoor facility.
d. Public outdoor recreation use of property acquired or developed with LWCF assistance is terminated.

The Draft EIS identifies a number of LWCF properties within the study area (Table 4-9 & 4-10); however, based on the analysis, it is unclear of the extent to which there might be potential conversions of these properties. The Final EIS should specifically identify the extent to which there would be any potential conversions. If any part of an LWCF property will be removed from outdoor recreation as a result of this project, the NPS and the Mississippi Department of Wildlife, Fisheries, and Parks or the Louisiana Department of Culture, Recreation and Tourism will need to be notified and consulted so the conversion of use can be satisfied following LWCF regulations and policies.

Additionally, Tables 4-9 and 4-10 identify LWCF properties created between 1965-2011. The tables should include LWCF properties through the current year, or a statement to explain that there have been no new LWCF properties since 2011 should be included. Finally, the Department notes that the source link for Table 4-9 is broken and requests that the Final EIS include a usable link.

The Department appreciates the opportunity to comment on this project. If the project has a potential to convert any LWCF property, please reach out to John McDade, LWCF Compliance Officer, at john_mcdade@nps.gov to discuss the matter further. I can be reached via email at joyce_stanley@ios.doi.gov or by phone at (404) 852-5414.

Sincerely,

Joyce A. Stanley, Ph.D.
Regional Environmental Officer

cc:

Christina Willis - FWS
John McDade – NPS
Roxanne Runkel – NPS
Jon Janowicz – USGS
OEPC - HQ

From: Dean, Kenneth <Dean.William-Kenneth@epa.gov>
Sent: Tuesday, August 27, 2024 4:05 PM
To: YazooBackwater MVK; Renacker, George M (Mike) CIV USARMY CEMVK (USA)
Cc: Gettle, Jeaneanne; Torres, Ramon; Scofield, Steven; Kajumba, Ntale; White, Douglas; Buskey, Traci P.
Subject: [Non-DoD Source] EPA Comment Letter on the Yazoo Backwater Area Water Management Project DEIS
Attachments: EPA Comments on the Yazoo DEIS (signed).pdf

Mr. Mike Renacker,

Attached is the U.S. Environmental Protection Agency's comment letter regarding the Draft Environmental Impact Statement for the Yazoo Backwater Area Water Management Project. If you have questions regarding our comments, you may contact Mr. Douglas White of the NEPA Section at (404) 562-8586 or white.douglas@epa.gov, or me at (404) 562-9378 or dean.william-kenneth@epa.gov.

Wm. Kenneth Dean
Acting Manager, NEPA Section
U.S. EPA, Region 4
61 Forsyth St., SW
Atlanta, GA 30303
Office: (404) 562-9378
Mobile: (678)-628-2079

From: Colie Hollowell
To: YazooBackwater MVK
Subject: [Non-DoD Source] .
Date: Tuesday, August 27, 2024 10:17:03 AM

I SUPPORT OPTION TWO

From:	Betsy Scott
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Alternative 2 is the only solution
Date:	Sunday, July 21, 2024 12:03:16 PM

My letter is lengthy, but so was our suffering.

On February 23, 2019 Hwy 465 closed disrupting access to homes and businesses at Eagle Lake. A Mandatory Evacuation Order for the Eagle Lake community was issued on either March 8 or 9th. As Low Water Bridge and access to Hwy 1 were inundated by backwater flooding the distance and hardship to get home or check on property increased. Full time residents were forced to either abandon their homes to live with relatives or friends, suffer costs of alternative housing or drive miles out of their way on poorly maintained roads to reach home and safeguard their property. We chose the latter while both still working. This commute added about 2 hours to our workday. I wish I could upload the hundreds of photos I have documenting this event. Below are excerpts from a diary of sorts that I kept in 2019:

2/23/19: Hwy 465 to Backwater/Mainline Levee closed. Day 1 of the disruption to our community.
3/4/10: Hwy 465 to the Gin and Eagle Lake Shore Rd (ELSR) closed.
3/8 or 3/9/19: Mandatory Evacuation Order issued
3/18/19: Backwater began seeping over areas of ELSR
3/23/19: Almost one month after Hwy 465 flooded, local residents began a massive sandbagging operation to protect homes and prevent the backwater from crossing ELSR and breaching Eagle Lake. Along with four other neighbors, we purchased our own pump and weeks of pumping backwater from our front yards back over the sandbags began.
4/4/19: Shortest route to Hwy 1 flooded by backwater, difficulty reaching homes and property increased.
4/9/19: Two layers of sandbags are holding the Backwater off ELSR and preventing the breach of Eagle Lake.
5/9/19: 47 days since the sandbagging effort began and 75 days since Hwy 465 flooded. Area residents, volunteers and inmates arranged by county law enforcement continue patching sandbags, adding layers and pumping backwater back into the field daily. Eagle Lake overtopped Muddy Bayou. We feel forgotten. The patients that I see and most of my colleagues have no idea what we are going through.
5/16/19: 54 days after the sandbagging of ELSR began, USACE brought an automatic sandbagger to the lake. Backwater (BW) 97.63’ and Eagle Lake (EL) 92.82’
5/17/19: Waves and rising backwater begin to topple the 3-4 stacked sandbag levee on ELSR. Jim (my husband) and I fill three trailers with sandbags and place around our house to divert the impending backwater breach and slow the rush of water directly against our home.
5/18/19: White capped waves coming across the cornfield and backwater. 56 days after the sandbagging effort began, ELSR was breached and water began rushing into Eagle Lake. Backwater (BW) 97.81’ and Eagle Lake (EL) 93.56’, a 4.31’ difference. We’re worried that the speed and volume of the water will wash away our foundation. Day 1 of water under our house.
5/19- 6/19/20: By day four or five the Backwater and Eagle Lake were equalized at 98.16’ and 98.15’. I left the lake in order to work, Jim working part time and stayed home to protect our property. Parked his truck behind the Brunswick levee and boated home. On 5/30/19 WLBT News does a story on the flooding and films Jim tying the boat to our back steps where the water is approximately 4’ deep. Spent the month: building a flood wall on the front steps to prevent waves reaching our front door that’s built at 101.5’, added tin and plywood wall to our latticed back porch that is approximately 5’ off the ground to prevent debris and waves from knocking out support structures, boated dogs to high ground 2-3 times daily to toilet and exercise, built sod patch on back porch for additional dog potty, boated in groceries and supplies and boated out trash, boated us both in and out as work allowed or required, watched our 2 slip boat house and pier slowly break apart, fed feral cats on nearby property, relocated an opossum and armadillo that swam to our porch to high ground and listened to a killdeer cry for her flooded babies for two days. We gathered pears floating around a tree next door and left them and dog food in different areas of our long commute for stranded animals. Startled an emaciated black bear off of Hwy 1 back into the floodwaters it was trying to escape. Unable to count the number of emaciated deer that we see.
6/24/19: Day 38 of water under our house and day 121 since Hwy 465 closed, a huge storm hit overnight. Woke to the sound of debris breaking through our back porch flood wall and power went out at 3 am. At daybreak we found our 12’ wide back steps washed off the porch, tin/plywood flood wall and porch lattice torn off, four support poles

broken and brick facade from under our bedroom windows and door knocked off the house. Spent the next several days taking off broken tin and lumber, tying off steps and floating debris and adding new support posts back under the house- all by boat in approximately 4' of floodwater. Power back on 5 days later, hauled spoiled freezer contents away by boat.
7/7- 7/14/19: Steele Bayou open intermittently. More storms. Lost deck between the house and shop. The deck built under three large pecan trees now floating and banging against the trunks. Reattached the back porch flood wall with longer bolts in preparation of Hurricane Barry hitting NOLA. Each storm that hit destroyed more of the boat house and pier dashing hope of any salvage. The Governor came to the lake on 7/14, two months after the Backwater and Eagle Lake equalized.
7/20- 8/3/19: The water is out of the elevated shop and the gravel drip line at the front of the house is visible underwater by days 64-65 of BW-EL equalization. Day 68 of equalization, able to drive through debris to reach the apartments next door and walk in boots across sandbags to reach home. Day 70, muddy, but water is completely out from underneath the house! Day 71, able to use our driveway to get home and drive groceries to the front door! Waste Management resumed garbage collection on 8/3.
8/15/19: Hwy 465 reopened at 6:00 pm, 173 days after closing- just shy of six months. Clean up and rebuilding continues through October.

We were but one of the estimated 687 homes impacted by the lack of pumps and incompletion of the 1941 flood plan. We estimated personal losses of approximately $80,000 that included damage to our property not covered by flood insurance. Even more damaging was the six month impact to our and our Delta neighbors' quality of life. Our Eagle Lake home serves as the gathering spot for our blended family. We missed birthday celebrations, Easter, Memorial Day, Independence Day and an entire summer of enjoyment together. We lost valuable time with each other, with our children and grandchildren. Damage from the flooding can still be seen today with the numerous mature hardwood trees that die and fall along Hwy 465. The installation of pumps and earliest starting date for pumping are imperative for the survival of the Mississippi Delta.
Alternative 2 is the best solution to protect the MS Delta's infrastructure, wildlife, agriculture, work force, access for emergency services, medical care and quality of life- and to insure that this prolonged man made tragedy does not occur again. FINISH THE PUMPS!

Betsy Bailey
840 Eagle Lake Shore Road
Vicksburg, MS 39183

From: Gloria Adcock
To: YazooBackwater MVK
Subject: [Non-DoD Source] Alternative 2 and adjusting the pump turn on to an earlier date.
Date: Monday, July 29, 2024 11:51:26 PM

I am Gloria Adcock, I have lived in the South Delta in Sharkey County all my life. My Father farmed for 60 years, and my husband and I have owed farm land most of our 64 year married life. My son leases my land now and continues to farm. My Grandson joined my Son and they continues to farm my land. My family has faught the backwater flooding for many years, some years have been worse than others, but every year flooding is a huge possibility. The installation of a pumping station at Steele Bayou is an answered prayer. I am in support of Alternative two.

I would also request that you consider adjusting the pump turn on to an earlier date. That would give us a little more time for the land to dry, so the best crop yield can be achieved.

Thank you for your consideration of Alternative 2 and adjusting the pump turn on to an earlier date.

Gloria Adcock

From:	Connie Miller
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Alternative Two
Date:	Friday, August 23, 2024 5:54:51 PM

I have followed the Corps of Engineers' investigations and publications and meetings on the devastating flooding that continues because of lack of sufficient controls.

I grew up on Highway 61N behind Deer Creek and lived with backwater flooding in the 60's and 70's, but nothing as devastating as in recent years. My childhood home was completely destroyed by the more recent floods. I am heartbroken.

I have immediate family (and friends) who live at Eagle Lake (2nd generation). I have seen and photographed the damages and helped clean flooded primary homes.

I implore you to install the pumps/systems to prevent the destruction of such a beautiful recreational area, as well as the lives of those who live there all other farms and families affected by this flooding.

I am in favor of Alternative 2.

Thank you for the opportunity to comment.

Constance L Miller
Brandon, Mississippi

From:	CYNTHIA HUBERT
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Comment submitted from website for Yazoo Backwater
Date:	Thursday, July 18, 2024 6:16:02 PM

Please finish this project! It’s been long overdue. Folks here need to be able to rest an not worry about flooding anymore
Sent from my iPhone

From: Haley Manor
To: YazooBackwater MVK
Subject: [Non-DoD Source] Comment submitted from website for Yazoo Backwater
Date: Tuesday, July 23, 2024 5:38:24 PM

OPTION #2. For farmers, families, wildlife!! Everything. #fixthepumps PLEASE!
Best regards,

Haley Manor
C: 601-500-2441

From:	Davis Darnell
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Finish The Pumps
Date:	Tuesday, August 27, 2024 10:26:15 AM

We need these pumps! You caused this problem by starting the backwater structure and now you need to finish it. We support option 2. Let's get it done. Thank You.

From:	diane klaus
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Finish the Pumps
Date:	Wednesday, July 3, 2024 10:08:11 AM

Ladies and gentlemen of the Corps, Department of Interior, Game and Fish and EPA, I am writing again to ask that you please finish the flood control project that has been studied and approved off again and on again to protect our communities. It seems whatever concessions we make, whatever we give up, the special interest groups will attack us. I have been to all of the meetings held on the pump project. I have written several emails, filled out cards, sat at tables explaining the problem of the "no pump" solution. The last meeting at the COE offices in Vicksburg we were told by the department representatives they and you will fight for us. You saw the harm, the destruction, the injustices inflicted upon the communities, farmers, trees, wildlife, rivers, lakes, and the mental health of the thousands of people affected by not having the pumping project completed.

Our home is on Eagle Lake. It floods too when the trapped rain rises. The 100 year old cypress trees, the banks of the lake, our property(piers) are destroyed when this happens. There are dozens of large cypress trees dead or dying right now. We have NOT recovered because the flooding always hangs over our head every time the river rises and the gates close to trap rain in the Yazoo Backwater Area. When the rain begins, I begin to panic and anxiety because I know that what happened before, will happen again. This is a preventable disaster.

Please, finish this project in my lifetime. This is such a beautiful place that is slowly being destroyed by an unnatural flood.

Thank you,

Diane Klaus

Eagle Lake, Mississippi

Sent from my iPhone

From: Diane Klaus
To: YazooBackwater MVK
Subject: [Non-DoD Source] Finish the Pumps
Date: Tuesday, August 27, 2024 9:58:55 AM

Dear Sirs,
I have family and friends that have lived through numerous, preventable flood events over the last 30 years in the Yazoo Backwater Area. They have waited while flood after flood destroyed their lives, business, farms, property, homes and not least the impact it has had on the environment.
In 2019/2020 over half of the deer population was starved to death. Terrestrial animals drown or were eaten by their own kind. I pray those opposing the pumping plant have been given the facts of what the flooding has done to the wetlands, the birds, the trees, the human injustice. I don't know why their opinion should even matter if they have not seen it with their own eyes. The people that have lived it for decades should be the ones heard. Most are only voting because they are told to. Lied to. Listen to us. We are the victims of a project that was walked away from, leaving us in a flood zone that was man made. There is no way around this but to install a pumping plant of any kind to keep the rainwater from filling up the backwater area and rotting it away.
Alternative two is the preferred solution out of the four choices we were given by the three major leaders making this decision. Why do you need anyone opposed to this to tell you what to do?This is pure torture to the lower delta. pumping plant is the only solution.
The Corps, EPA, etc.. have bounced solutions back and forth for years. You are working together now. WHY do you need groups to tell you THE GOVERNMENT what to do. They have an agenda of making money from donations. This is how they make money. They are using this to make millions. Anyone with any sense can see this is destroying everything they pretend to care for. WE are the stewards, not them.
Listen to the victims. You promised to protect us, do it.
Thank you.

From: Dylan Scott
To: YazooBackwater MVK
Subject: [Non-DoD Source] Option 2 Finish The Pumps
Date: Tuesday, August 27, 2024 6:44:44 PM

I’m resident of Clinton. I work as a research engineer at ERDC. My mother, step father, brother, SIL, and 2 nephews live in the Eagle lake community. They were deeply affected by the 2019 flood, and other preventable backwater flooding disasters. Please protect our communities, our environment, and our farmers by constructing the pumps.

Thank you,
Dylan Scott

From:	Delaine Stoner
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Please Finish the PUMPS!
Date:	Wednesday, July 31, 2024 8:37:40 AM
Attachments:	flood letter 207312024.pdf flood letter 107312024.pdf flood letter 307312024.pdf flood letter 407312024.pdf

Attached is the speech that I wanted to give at the meeting in Rolling Fork, but felt uncomfortable doing so as I don't do well speaking in public, unfortunately. These are just some of the experiences that I went through in the Flood of 2019. My neighbors went through similar situations and in many cases worse, none of which we deserved due to this government manmade flood. Please be empathic and realize you wouldn't want this for yourself either. This is something I pray we NEVER have to go through again and we SHOULD'NT.

Thank you,
Delaine Stoner
Holly Bluff, MS

Good Afternoon. My name is Melanie Stoner. I am a resident of Holly Bluff, Ms located in the South Delta.

The Flood of 2019 was a dark time for us in Holly Bluff and those in many other areas of the South Delta. It was a time filled with fear, uncertainty and anxiety! It was especially hard for my husband Joe who suffered at the time from ALZ and for me, too, as his only caregiver. Confusion is paramount with ALZ's and seeing our home surrounded by water like a reservoir only exacerbated his confusion. He was also panicked that the flood waters were preventing our family from planting a crop and that our livelihood was in jeopardy. And he had every reason to be panicked because we, in fact, did not plant our land that year in the South Delta. I believe that the stress of living through this 6 month ordeal accelerated the progression of his disease. Yes, stress will do that, and unfortunately, it wasn't too long after the flood waters receded that sadly he passed away.

We also lived through the constant fear that with the potential threat of rainy weather conditions, and the fact that our area was labeled as that of a bathtub situation, that our home would eventually be flooded as well. Thankfully, by the Grace of God, it did not.

The threat of vandalism was another fear + consideration. That is why we chose to stay in our home throughout this Hellish ordeal, but it was not easy! Just imagine not being able to flush your toilets during this 6 month crisis?! At that point we had to resort to using camping style tactics. Use your imagination as to what that entailed! Believe me, it was not pleasant and all the while being the sole caregiver to my sick + confused husband. No, it was not easy. It was like living in a 3RD World country + it did not have to be that way. This is just one of many situations we encountered that were terrible. I could literally go on and on for hours...

Not only did we suffer horrible conditions, but so did the poor wildlife. It was heartbreaking to see herds of starving deer running through the deep flood waters seeking high ground. Seeing their carcasses littering the landscape as the water receded was a devastating sight. If you care anything about wildlife, you don't want them to have to endure a flood. They do not fair well contradictory to what some in the government and others may think. We saw the horror with our own eyes! We lived it for 6 HARD MONTHS!

~~xxxx~~ No human + no animal should have to go through the horror of a flood, especia one that is categorically known ~~that~~ to be man made by the United States Government. Some in the government + others on the outside suggest we ought to just pack up and abandon our homes + land that has been in our families for over a century. The land that incidentally is a major source of our income + livelihood.

How would you feel if you were in our shoes + someone told you that?? How would you feel if you were told you had to leave everything that you had ever known?? I have no doubt whatsoever that you would feel the same exact way as we all do here in the South Delta. Especially when this all could have been avoided many, many decades ago!

I ask you to please do the right thing + finish our pumps so we can feel secure again knowing our homes + livelihood are no longer being threatened by again, man made floodi

Thank you for your time today.

Please do alternative #2 with earlier cut on dates. Thank you!

From: jackie henne kerr
To: YazooBackwater MVK
Subject: [Non-DoD Source] Pumps option 2 justification
Date: Monday, August 12, 2024 7:08:14 PM
Attachments: my wetlands story.docx
my story.pptx
cross section of south delta topography.pptx

To whom it may concern:

Sometimes it feels like people think this issue is farmers against environmentalists. With the farmers saying the pumps will help farmers and local residents and the environmentalists saying the pumps will hurt the environment.

As a conservationist who lived and worked as a biologist and in forest management in the South Delta for nearly 20 years, I am saying **the pumps will help the hardwood forests and associated wetlands.** The degradation of the Bottomland hardwoods and associated wetlands due to the lack of pumps is so evident – Look at Delta National Forest. Farm crop growing seasons are mentioned, but not hardwood forest growing seasons and not wetland vegetation growing seasons. All plants have growing seasons and only truly aquatic plants can grow and be healthy when under or in standing water during their growing season. Cypress are not even truly aquatic plants and need to dry out sometime.

Please find attached a diagram and a story "My Wetland" depicting what should happen in the seasonal wetlands in the South Delta and what happens when the backwater flood water has been held up behind the gates due to the lack of pumps during the growing season.

No one is advocating removing normal rain water that filled these wetlands during winter rains; just removing man made flood water.

I am also attaching a diagram of a cross section of Delta National Forest with flood waters standing at elevations associated with the backwater flooding. Please note I have not been able to get exact topography and tree heights on the same diagram. The elevation differences max out at about 10 feet while the trees can be 100 feet tall. I am working on a way to show this more accurately, but it does show the problem with holding water at 93 and above into the growing season. The hardwood ridges need to be above the water or saturation line by March so the roots of the hardwood trees can dry out and be healthy. As the water lowers due to percolation, evaporation, vegetation uptake and normal draining, vegetation that can tolerate ground saturation later in the year (its growing season) will leaf out and flourish later in the year as the normal water goes down. If water levels are held above the elevations of the side slopes, steps, bottom slopes and bottoms, no vegetation can grow and produce seed causing irreparable damage to the wetlands and associated wildlife dependent on that vegetation to feed, shelter and raise young.

Thank you,

Jackie Henne-Kerr

6684 Attala county highway 14
Goodman, MS 39079
1662-820-4783 please leave message and I will return your call.

To whom it may concern. This is a justification for the Yazoo Backwater Pump to be completed and why option #2 is the best option.

As a waterfowl biologist and hunting guide I want to tell the story of degradation of the South Delta wetlands over the last 50/60 years. It begins when the Yazoo Backwater Project was almost finished … but the last piece -- THE PUMP -- was not constructed.

Many people that have not lived and worked with wetlands extensively believe that wetlands need water (the more the better – right?) And if you remove water, you destroy wetlands. As crazy as it sounds this is not always the case. It depends the type of wetland, how much water it needs and what season it needs to be wet and/or dry. Most of the wetlands here in the South Delta are not permanent, but seasonal wetlands. Historically they fill during winter rains, and were dry by July. The periodic spring flooding of the Mississippi River in past centuries did not have a significant impact on the annual filling of these wetlands. If the River did overtop is banks, the flood waters rose over the already full wetlands and the ridges around them for several days in early spring, then drained out quickly.

My Wetland Story summarize seasonal or monthly changes to a wetland in the South Delta during a normal water event and how the vegetation, wildlife and in particular waterfowl adapted to this natural rhythm.

Introduction

Think about a soup bowl you get in a fancy restaurant. The outer rim represents the ridges where the hardwood trees such as willow oak, water oak, sweetgum, green ash and sweet pecan make up the forest overstory. Maples, mulberry, pawpaw and winged elm are in the understory. Then there is the upper slope from the edge or ridge that goes down to a step or flat (the chef sprinkles the parsley or other herbs on this flat in your soup bowl.) On this upper slope in my wetland there is a transition of overstory species. There is willow oak, sugarberry, scycamore, nuttal oak, water hickory, persimmon and overcup oak. In my wetland, parsley doesn't grow on the step or flat, but cottonwood and willow dominate this area. There is another slope to the bottom of the wetland (or bowl where your soup is.) The difference between my wetland and your soup bowl is that the wetland has ridges in the bottom, most less than a foot high, but significant none the less. Plus, my wetland it is not round, but elongated because it's the ruminant of an old oxbow lake. On the bottom slope and the ridges in the bottom of the wetland the cypress and buttonbush grow. The flat bottom of my wetland (where your soup is) does not have woody overstory. It dries up too late in the year and too fast for trees to grow. But that's ok, it is ideal for warm season plants like grasses and sedges. And let me say that is really good for wintering waterfowl. My story describes the annual cycle of my wetland in a historical and/or normal water annual event.

MY WETLAND'S STORY

Starting in early spring say February/March, my wetland is full from the winter rains as are other wetlands in the area. In the past, if the Mississippi River flooded, my wetland was topped with this flood water, but it left quickly as the River receded. At this time the upland mid-story and understory vegetation around my wetland sprouted quickly to gather the sunlight before the hardwoods leaf-out and blocked the sun from getting to the forest floor. And before you know it with the flood water off the ridges, the overstory trees leaf out also. My wetland is still full of water.

March comes and goes, water in the wetland soak into the ground and begins to evaporate due to the warmer, sunny weather. The upper slope of the soup bowl begins to emerge as the water goes down. There is a new flush of green; different types of trees, shrubs and herbaceous vegetation grow on this upper slope due to timing of when the water leaves.

During April again, evaporation and infiltration lowers the water in my wetland. The bottom of the upper slope is now greening up; and another vegetation community will ring my wetland in this area.

In May we have "snow storms" of willow and cottonwood seed floating on the winds trying to find a place to land and germinate. With the water levels dropping and the step becoming a mudflat, it is perfect timing for these trees to get started! If there are already cottonwood and willows established the seeds will germinate providing food for deer and other animals, but they won't make it through the year. They need full sunlight to survive. Willow tree leaves are thin and drooping and cottonwood leaf petioles are flattened so their leaves hang down also, allowing for some sunlight to reach the forest floor. This small amount of sunlight allows the seedlings, smart weed, beaked rush and other ground cover to germinate grow. This vegetation is so important for wintering waterfowl and other animals that live in and around my wetland.

As June progresses, the lower slopes of my wetland are now drying out. On these slopes and on the ridges in the bottoms is a cypress/buttonbush community. Buttonbush thickets form at the base of the cypress and on the ridges in the bottom of the wetland. These species can tolerate a lot of water, but not if it overtops the tips of the plants and stay too long into to July. The hot water will actually scald young trees and shrubs. Sedges and rushes also take hold in these areas when the water leaves at the right time.

And then July comes to my wetland; and it is hot and dry. The bottom of the wetland is now a mud flat; grasses, millets and other warm season vegetation begin to grow. They have to grow fast, the bottom dries so quickly that they don't have much time before the moisture is gone. Woody vegetation doesn't grow in the bottoms, the season and moisture dictate what grows here. By the end of July, the plants we call moist soil plants have matured and produced a layer of seeds sometimes inches thick in these bottoms. As I walk through my wetland at this time the seeds poof up like clouds of dust on a country road. This seed bank is so important for the wildlife especially waterfowl and it NEEDS to be here in the bottom, not on the slopes or ridges, trust me you will find out why as you continue to read my wetland's story.

Now it is August, the bottom of the wetland begins to crack the moisture goes deeper and deeper into the ground. Cracks as wide as 6 inches and several feet deep are present in some areas in the bottom of my wetland. Nothing is growing, but the feast is laid in preparation for winter.

September bring early fall rains. The cracks close as the moisture gets closer and closer to the surface of my wetland bottom. All other levels of the slough; bottom ridges, lower slope, the step and upper slope and ridges have seeds maturing. It is so exciting to imagine what will happen this winter. There are a few places in my wetland that has several inches of water standing; just enough for the Blue-wing Teal to stop and fill up and rest on their migration to the southern tip of South America.

October and November bring more rains and water deepens in my wetland; up to 12 inches or so. Mallards, Wigeons, Gadwalls, Green-winged Teal and more arrive for their winter stay. All those seeds are there for them to feast on through the winter months.

December and more rain. Now the water in the slough bottom is too deep for the dabbling ducks to get the seed; but that's ok, they probably already ate most of it and now the water depth on the bottom ridges and lower slope is just right for them to get button bush and other seeds dropped there.

January rains raise the water into the willow/cottonwood flats. The ground vegetation there is very leafy and it and the willow and cottonwood leaves and branches are perfect for aquatic insects to live. Waterfowl at this time are preparing for molt, migration, and egg production. The birds need these insect larvae for the required nutrients. Ducks are also beginning to make pair bonds, the deeper water around the buttonbushes and the willow and cottonwood trunks are necessary for seclusion.

Its February again, water is now near the top of my slough, ducks are utilizing seeds and acorns in this area as they migrate out to their summer nesting grounds. The cycle ends and a new one can begin.

But…. do you know what happens to my wetland during years when the Yazoo Back Water pools up against the structure. 2019 and 2020 were the worst I ever saw. Winter rains filled up my wetland like any other year. BUT, then the backwater flooded on top of the winter rain water. It was so high it was at least 10 feet deep on the ridges around my wetland. March came and went, the water remained. The understory plants on the ridges did not sprout, the over story trees did. At this time water around their roots can still be tolerated. April came and went, the water remained. The understory plants on the upper slope did not flush, some understory trees and shrubs were completely under water. Now the ridge species of hardwoods were feeling the effects of warmer water and no aeration around their roots. May came and went, the water remained. Cottonwood and willow seeds never landed on mudflats, so they didn't germinate to provide food for deer, rabbits and other herbivores. Understory and ground nesting bird could not nest, their habitat was still under water. Turkeys remained in the trees constantly moving around looking for dry ground to nest, their bodies weakening from lack of quality food. The Mississippi River Levee is near my slough and it was not under water. All the animals and ground nesting birds that could sought refuge on the levee, but there was not enough area or protection. Turkey, and other ground nesting birds as well as rabbits and other prey species were killed by predators. My wetland was still under water in June and July; briers did not grow, cane was under water and did not sprout, no vegetation grew in or around my wetland. On the levee, most animals died of starvation if not preyed upon. Dead deer were everywhere, even raccoons and turtles and other animals that sought refuge on the levee were starving or being eating. Finally, the Steel Bayou Gates were opened and the flood waters began to recede. But it was too late for understory, and ground cover to grow in my wetland. The bottom never did completely dry out, so nothing grew there. When the winter rains came there was no seeds for the wintering waterfowl. They had to move on to other areas to find food and they had other birds there, to compete with. This excessive flooding is not something the vegetation and wildlife in my wetland and others in the South Delta can withstand. The bottomland hardwoods weaken and many die or fall because their roots are rotten from the flood water over their roots in the growing season. Cottonwood and willow will also become weak, buttonbush and other understory species will not survive. The ecosystem of my wetland and other wetlands are weak and sickly. For my wetland and others to be healthy and functional here in the South Delta, the EXCESS flood water due to the incomplete Yazoo Backwater Project has to be removed by the end of March, so the normal winter rain water can slowly lower as it needs to. The wetland vegetation needs the pump as much as the farm crops do. THE WETLANDS WILL STILL HAVE WATER LIKE THEY SHOULD because the pumps will only remove the excess back water. Wetland species like bottomland hardwoods and other plant communities in the South Delta have a growing season, they need be free of water during that time.

Thanks so much for listening,

Jackie Kerr,
12315 Highway 1
Rolling Fork, MS 39159
662-820-4783

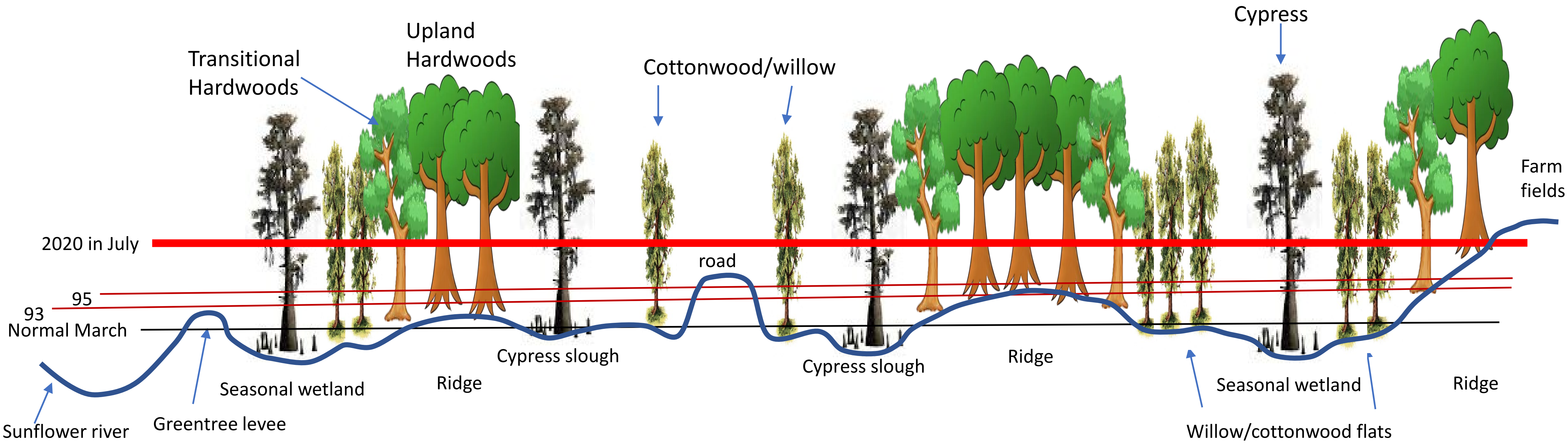
Normal March – no backwater being held up and no Mississippi River water backing in, Winter rains have the wetlands filled but no backwater pooling behind the gates.

93 - is the level the gates/pump will hold the backwater at till the gates can be opened-Mississippi River down

95 - Is the level the gate/pump will hold the water at till the gates can be opened-Mississippi River down

2020 in July - was the level of the water in 2020 in July without the pumps and extreme backwater and late high river.

Note: this is my hand drawing, showing the general situation on Delta National Forest Scale is not exact.



PLEASE NOTE: The lack of pumps are degrading our wetlands in the south delta, not helping them.

- The 93 and 95 levels will be holding water over hardwood ridges during the trees growing season on Delta National Forest and other forested tracts in the south delta, this is detrimental to the trees on the ridges. Just like farm crops die if flooded during the growing season, so do bottomland hardwoods and associated vegetation like pondberry.
- The 93 and 95 levels will be holding an extra 6-8 feet of water over the seasonal wetlands and cypress sloughs. The excess water has to evaporate off before evaporation can remove the normal water in these areas, pushing dry down back by months causing species lost on the cottonwood flats, seasonal wetlands, and the cypress/buttonbush ridges and the bottoms of these wetlands.

From: Eddie Hollowell
To: YazooBackwater MVK
Subject: [Non-DoD Source] Pumps
Date: Tuesday, August 27, 2024 10:54:20 AM
Attachments: image001.png

I support option 2.

Eddie Hollowell
HR/Safety Manager (COSS)
Titan Engineering & Construction
Cell 601-529-8726
Office 601-898-2525
eddie@titanengr.com

From:	Dianne Ashley
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Yazoo Backwater Comment
Date:	Tuesday, August 27, 2024 12:03:14 PM

My husband and I lived through the Back Water Flood of 2019. We have a home on Eagle Lake Shore Road which is close to where the back water broke through the sand bags that Eagle Lake residents had laboriously placed for miles along the side of the road to keep the back water from entering Eagle Lake and equalizing. When the back water broke through after a storm blew away some of the sand bags, the water crossed the road and we essentially had a water fall that washed out the neighbor's 100 foot lot. During this flood fight, Eagle Lake residents and others struggled to fill sand bags to keep our homes from flooding. We fought valiantly but lost the fight in May when the back water and the lake equalized at an elevation of about 98.2 feet. This flooded many of our roads. We were told to evacuate. Where were we supposed to go? Our homes were inaccessible. FEMA finally did give us a pittance for housing but not enough to cover our costs for housing during the 3 month period that we were not able to get back home. It was a horrible, stressful time in our lives made worse by the knowledge that this could have been prevented years ago if promises had been kept by our government. It is hard for us to believe that our fight to get the pumps installed to keep our homes from flooding from this man made situation is still being studied and delayed ad nauseam! It is also hard to believe that this project was completed up until the pump installation. This means that the back water flooding was made worse for our area when the project funneled all of the back water from Memphis, south through Steele Bayou where it can't go anywhere if the river is too high and the locks have to be closed. The final step to this project was to build the pumps which is yet to be done due to ridiculous claims made by
Environmental Groups who don't have a clue. They do not live here. This is not their home. We are hoping that no more studies will be done. It is time to right the wrong that has impacted our homes and our community. This could be a beautiful, economically vibrant community if the pumps were built. Do the right thing and keep your promises. We are the only back water community who do not have pumps. Is this right? Is this fair to our community? We have seen the devastation and lived it. We have seen the animals dying of starvation and drowning. We have seen the beautiful trees falling over and dying, even to this day because their roots were covered in water for so long. How can this flooding be considered good for the environment?

Alternative 2 is the only viable option.

Dianne and Robert Ashley

Sent from Mail for Windows

From: David Mann
To: YazooBackwater MVK
Subject: [Non-DoD Source] Yazoo backwater flooding
Date: Sunday, July 21, 2024 12:49:06 PM

I support the Yazoo backwater pumping plan to help relieve backwater flooding in the lower Mississippi Delta. I am 72 years old and in 1973 as a member of the Mississippi National Guard I was called out to help people evacuate during the 1973 flood and I witnessed first hand the hardships the 1973 flood caused people, animals and the devation it caused crops, plant life and infrastructure.

The area of Mississippi where I'm from the old people always talked about the flood years of 1913, 1927, 1937. It was hard for me to imagine the water levels they talked about as I looked out across dry dusty farm fields and for the most part dry woodland until I saw it for myself in 1973.

After the 1973 flood I started researching for myself and soon found out the lower delta flooding problem had been recognized since the 1920's and studied by the US Corp of Engineers and a plan had been submitted as early as 1940. But nothing happened.

There have been numerous floods since 1973 with the most notable 2011 and still nothing has happened except political tom foolery. The people living in the lower Mississippi delta deserved better than this.

My support for backwater flooding relief is unwavering.

Sincerely

David N Mann Sr.
3231 Highway 1
Issaquena County Mississippi

From:	Eddie King
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Yazoo Backwater Project
Date:	Tuesday, August 27, 2024 7:06:17 PM

I'm support and encourage you to proceed with option 2:

Alt 2 - Construct a pump station with an earlier turn-on date

Sent from Yahoo Mail for iPhone

From:	Dale R Jacobs
To:	YazooBackwater MVK
Cc:	Dale R Jacobs
Subject:	[Non-DoD Source] Yazoo Backwater Pumps, I"m FOR it
Date:	Monday, August 26, 2024 3:03:29 PM
Attachments:	image001.png

As a property owner at Eagle Lake I am most definitely FOR the installation of backwater pumps. My choice would be option 2, but at this point I'll take any option. There is obviously a solution to correct the problem of backwater flooding that has been known for a very long time. The groups that oppose these pumps that will only run under clearly defined circumstances do not live or make a living in the south delta and have not personally witnessed the environmental damage during and after these flooding events. It's amazing how much of a fight it has been to finish a project to keep land that is 87' above sea level from flooding. If this was impacting New Orleans that is approximately 87' lower, there would not be a debate it would just get corrected. The residents of the south delta deserve the implementation of the backwater pumps. We shouldn't have to worry every spring that our lives will be turned upside down for months due to flooding when there is a known/proven solution to correct the problem. I appreciate the work that USACE, MS Levee Board, MS state officials, and the MS congressional delegation have done to help bring this problem to a positive resolution. Please let's get the backwater pump project completed like it was originally intended to do many years ago as part of the backwater levee project.

Dale Jacobs
International Paper Vicksburg Mill- Capital Projects Engineer V
601-631-8219 (W)
601-529-8202 (C)
International Paper

>
> Sent from my iPhone

From:	Evelyn Carter
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Yazoo backwater pumps
Date:	Tuesday, August 27, 2024 4:47:54 PM

I have seen the devastation!! The destruction! Homes and businesses totally destroyed! Dead animals floating in many feet of water. Death, disease, destruction! It is WAY past time to get these pumps installed and running!
E carter
Sent from my iPhone

From: Frank Melton
To: YazooBackwater MVK
Subject: [Non-DoD Source] Yazoo Backwater pumps
Date: Thursday, July 4, 2024 9:11:11 AM

I am for the pumps! Let's protect our families, productive farmland and wildlife from future flooding!

Build the pumps!

Sent from my iPhone

From: Donald Roesch
To: YazooBackwater MVK
Subject: [Non-DoD Source] Yazoo Backwater Report
Date: Tuesday, August 27, 2024 8:08:47 PM

I support alternative 2 of the Yazoo Backwater Report. This is the most beneficial option for the people of Mississippi, the state's economy, and the wildlife that inhabits the area.

Donald Roesch

Sent from my iPhone

From: diane klaus
To: YazooBackwater MVK
Subject: [Non-DoD Source] Yazoo Backwater
Date: Wednesday, July 31, 2024 10:52:05 AM

To the USACE, EPA, and all parties working on the flood relief that is an environmental and human injustice,
My name is Diane Klaus. I have sent in a previous response, stood before the panel in Vicksburg and gave a small speech on the 2019 flood impact. After that meeting, I feel I did not go into detail about another impact the water causes.
It was mentioned that roads would be raised to allow access for flood victims to travel while flooding is high. Unless those roads are protected with riprap the wave action from flooded fields will erode those roads as it did during previous flood events. Some of the damage done in those years have not been repaired and there are piles of large riprap that were placed on 465 near the Eagle Lake community to try and save a portion of that highway where two cross culverts are located. Mailboxes were also undermined, washed over and had to be repaired. Yes, the roads can be raised but if the water is high, the wave action WILL wash away the sides and the infrastructure raised will eventually fail too.
Again we need the flood protection with alternative 2, and the capability of lowering it more if needed. A large rain event will exceed the 90’ very quickly.
Protect and save wildlife, communities, agriculture, infrastructure, businesses, and those who have invested their lives into their forever homes with no where to go. Don’t treat us like the wildlife and trees that are dispensable any longer. We are human beings who want to live in peace and not fear our government forgets us again.
Thank you again,
Diane Klaus
Sent from my iPhone

From:	Gary Brown
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Yazoo Pumps
Date:	Tuesday, August 27, 2024 2:28:40 PM

I support Alternative 2 on the Yazoo Backwater pumps. It needs to happen now!

Sent from my iPhone

COMMENT CARD

Yazoo Backwater Area Water Management DEIS Public Meeting

* Please note all fields are optional.

Name: Delaine Stoner

Phone: 662-571-6469

Address: 6661 Satartia Road
P.O. Box 145
Holly Bluff, Ms 39088

Email: deltadarling2002@yahoo.com

AREAS OF CONCERN

* Check all that apply.

- [x] Home Accessibility
- [x] Housing or Property Impact
- [x] Access to Emergency Services
- [x] Impacts to Wildlife
- [x] Other: ______
- [x] Impacts the wetlands/environment
- [x] Infrastructure (Electricity or Road Accessibility)
- [x] Agriculture (Flooding of Farmland or Loss of Livestock)
- [x] Hunting or Outdoor Recreation

COMMENTS, QUESTIONS OR SUGGESTIONS:

Please finish the pumps with alt. # 2 with earlier cut on dates.

From:	Angela Hudson
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Alternative 2
Date:	Monday, July 29, 2024 10:49:29 PM

I am Angela Hudson a third generation farming and land owner and am in support of Alternative 2; Crop Season (16Mar-15Oct) and non-crop season (16Oct-15Mar)
Structural:
25,000 CFS pumping station at Steele Bayou.

I would like for you to consider adjusting the pump turn on to a earlier date.

From:	Bill Harris
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] comment on Yazoo Backwater project
Date:	Tuesday, July 16, 2024 9:26:56 PM

I'd like to submit these comments concerning the DEIS of the Yazoo Backwater pump project. I'm a property owner in the south delta and was impacted by the floods of 2019 & 2020. The devastation caused by these floods to residents and property owners is well documented. The negative environmental impact on the wildlife, trees and land of the long duration of the flood has also been well documented. As the information in the federal register states, the Yazoo project is the only backwater project that was authorized that still does not have pumps built. It's time for the Federal Government to keep the promises made to the south delta and build the pumps. The national groups that are opposed to this project didn't witness first hand the devastation that we saw in 2019. They didn't drive the levees and see the large number of animals forced to live on the levees. They didn't see the loss of trees in later years due to the long duration of the flood. They didn't see residents forced to pack up and move out, not knowing when they would be able to come back, and what they would come back to, and they won't be there when it happens again. Prevent the next flood from having the impact on the region that occurred in 2019. Finish the pumps.

Thank you.

Bill harris.

From:	Bruce Hollowell
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Comment submitted from website for Yazoo Backwater
Date:	Tuesday, August 27, 2024 2:30:13 PM

I support the pumps. Option two. Thank you.

From: Bethany Smith
To: YazooBackwater MVK
Subject: [Non-DoD Source] Comment submitted from website for Yazoo Backwater
Date: Tuesday, August 27, 2024 7:45:36 PM

Please consider option 2 for helping to control the back water flooding in the Mississippi Delta . I have first hand witnessed the devastation to the land and to the animals - it was heartbreaking
to pass land dwelling animals that were stranded and starving. The addition of pumps at Steele Bayou would help - I understand they will not completely stop all flooding but to help minimize the loss of wildlife and land damage.

From:	Aly Scott
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Finish the pumps!!!!
Date:	Tuesday, August 27, 2024 4:56:59 PM

I support alternative 2. Coming from a girl that has lived her entire life in the delta and now hopefully so will our 3 children- I am in strong support of the pumps to put in place. The devastation we witnessed in 2019 and what we lived through will forever be in my mind and on my heart to continue to pursue the right thing to do for not only our communities, but our wildlife.

Sincerely,
The Scott family

Sent from my iPhone

From:	Bump Callaway
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Finish the pumps!
Date:	Tuesday, August 27, 2024 9:38:18 PM

I am a resident of the Eagle Lake Community and was a resident during the recent flood events during 2019 and 2020. I wish to voice my support for Option 2.

L. W. Callaway
16353 Hwy 465
Vicksburg, MS 39183
Phone: 601-218-8998

Sent from my iPhone

From:	Gex, Joe J
To:	YazooBackwater MVK
Subject:	[Non-DoD Source]
Date:	Tuesday, August 27, 2024 8:18:38 PM

I support alternative 2
Sent from my iPad

From:	Keith Gmail
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Backwater Pump Alternative 2
Date:	Tuesday, August 27, 2024 9:46:21 PM

Please pass Alternative 2. I watched my parents suffer. I witnessed wildlife that have yet to recover starve and die. Communities were ripped apart. The flood of 2019 did enough damage to last lifetimes. Please complete this project so that my family can continue their legacy. I support Alternative 2.

Keith Klaus
Madison, MS

From:	John Harris
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Build the pumps
Date:	Friday, August 23, 2024 6:41:33 PM

I was directly impacted by the flooding in the south delta. Please fix the pumps.

Sent from my iPhone

From: John Murry Greenlee
To: YazooBackwater MVK
Subject: [Non-DoD Source] Comment submitted from website for Yazoo Backwater
Date: Monday, July 29, 2024 5:54:44 PM

I vote in favor of Alternative #2 and would ask that you please consider adjustments to the pump-on elevations and dates.

Thanks
John Murry Greenlee

JOHN MURRY GREENLEE
President - Mississippi Delta

200 Jerry Clower Blvd
Yazoo City, MS | 39194

o | (662)746-0391
c | (662)571-0531
f | (662)746-7796
e | JohnGreenlee@BankPlus.net

NMLS | 705043

BankPlus website

From: Kayla
To: YazooBackwater MVK
Subject: [Non-DoD Source] Comment submitted from website for Yazoo Backwater
Date: Tuesday, August 27, 2024 12:04:01 PM

We support option #2
Sent from my iPhone

From:	Justin Brooks
To:	YazooBackwater MVK
Cc:	Scott Lemmons; Robert Manes
Subject:	[Non-DoD Source] Comment submitted from website for Yazoo Backwater
Date:	Thursday, August 15, 2024 3:29:36 PM
Attachments:	Yazoo Backwater Area Water Management Project - 2024 - TNC MS Public Comments.pdf

Hello –

Attached you will find The Nature Conservancy's public comments for the draft EIS for the Yazoo Backwater Area Water Management Project.

Thanks,

Justin

Justin Brooks | Director of Government Relations
m. 601.934.4337 | justin.brooks@tnc.org | www.nature.org/mississippi
The Nature Conservancy

The Nature Conservancy

August 15, 2024

Attention: CEMVK-PPMD
Vicksburg District, U.S. Army Corps of Engineers
4155 Clay Street
Vicksburg, MS 39183

RE: Notice of Public Comment period for the Draft Environmental Impact Statement for the Yazoo Backwater Area Water Management Project

Dear Colonel Gipson:

Please accept the following as The Nature Conservancy's, Mississippi Chapter, comments on the Draft Environmental Impact Study to Yazoo Backwater Area Water Management Project. The Nature Conservancy (the Conservancy) is a global organization dedicated to conserving the lands and waters on which all life depends. Guided by science, we create and support innovative, on-the-ground solutions to our world's toughest environmental challenges to ensure that nature and people can thrive together. We use a collaborative approach that engages local communities, governments, the private sector, and other partners. In Mississippi, we've worked with both private and public partners for more than 40 years to conserve over 165,0000 acres of land and water across the state. During this time, the Conservancy has worked to conserve and restore wetlands in the Yazoo River Basin, while also helping to establish numerous National Wildlife Refuges and Wildlife Management Areas across the Mississippi Delta. Due to prolonged and reoccurring flood conditions and associated harmful impact on both people and nature, the Conservancy supports moving forward with a proposed flood control measure that alleviates chronic flooding and provides habitat benefits through structural and non-structural components.

The southern portion of the Mississippi Delta continues to experience significant flooding that negatively impacts the surrounding communities, economies, and natural resources. Historic flooding in 2019 and 2020 resulted in fatalities, hundreds of millions of dollars in damages, significant impacts to wildlife, and flooding of nearly half a million acres and hundreds of homes. Current climate projections indicate the number of extreme weather events will become more frequent and reflects that the status quo is no longer a viable option for the region's natural resources nor its residents. Over the years, this project has seen many renditions, which has led to the unprecedented interagency collaboration between the U.S. Army Corps of Engineers, the U.S. Fish & Wildlife Service, and the U.S. Environmental Protection Agency.

We believe the proposed plans for both Alternative 2 and Alternative 3 include sought out solutions that incorporate and respect the thoughts, concerns, and experiences of the Yazoo

Post Office Box 2444
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Fax: (601) 510-3271
nature.org/mississippi

Backwater Area residents, while also staying in compliance with the Clean Water Act, National Environmental Policy Act and other applicable laws and regulations. These plans include a suite of structural and nonstructural components including pump stations, seasonal pump operations, low flow wells, buy-outs, and structural floodproofing.

In response to previous criticisms, the 2024 Draft Environmental Impact Statement (DEIS) provides a new wetland analysis which encompasses a larger study area that includes the entirety of the five-year floodplain. According to the DEIS, there are no estimated changes to convert wetlands to non-wetland habitats. Also included in the proposed alternatives are the installation of 34 supplemental low flow wells along the mainstem levee of the Mississippi River. These proposed wells could improve minimum base flows, enhance habitat, and improve standing stock for aquatic species throughout the watershed. Due to increased water withdrawals associated with agricultural production, the region continues to experience low to no flow conditions throughout the fall season.

Eighty percent of the population located within the Yazoo Study Area (YSA) primarily consists of low-income and disadvantaged communities. As stated in the DEIS, the region's per capita income is less than $19,000 annually and the average unemployment rate is 3-5% higher than the state unemployment rate. The severity of the issue from a socioeconomic standpoint is apparent; without a change in water management, these communities will continue to be adversely impacted and the effects on minority and low-income areas will be disproportionally high. For residents living within the 2-year floodplain (90ft), the proposal recommends mandatory acquisitions of all structures including approximately 55 residential structures. With respect to residents of the YSA, the Conservancy recommends continued dialogue to address mandatory vs. voluntary acquisitions within the 2-year floodplain. As it relates to downstream communities, modeling in the DEIS suggests that there are no adverse impacts due to structural components of the project. Modeling was based on additional water pumped from the YSA into the Yazoo River during the peak of the Mississippi River flood in 2011. The additional water capacity from a 25,000cfs pump resulted in minimal impacts registered on the Vicksburg gage measuring 0.4 feet.

The Conservancy supports securing all compensatory mitigation sites prior to construction of the project. After project completion, we believe it is important to continue monitoring the pump station operations and analyze long-term efficiency to validate the project's successes. We recommend an adaptive management approach that allows for science-based operational guidance.

The Conservancy recognizes that many things have changed across the Mississippi River Basin since Congress authorized the current system of flood control measures along the Mississippi River in 1941. There is a dire need for a more effective long-term approach to water management across the entire basin. The severe impacts of the 2019 flood heightened collaboration between federal agencies and focused attention and resources within the federal government, prompting renewed interest in the development of a solution for the Yazoo Backwater Area. These proposed solutions provide significant flood risk reduction for communities and local economies while also minimizing impacts to the environment. We believe that plans being considered without structural components, due to their inability to reduce flooding from the landscape, are not practical and provide limited benefits to the region. The Conservancy supports moving forward with the water management plan that best alleviates chronic flooding and provides benefits to both people and nature.

The Conservancy remains available to offer its resources and assistance moving forward in both the Yazoo and larger Mississippi River Basins. We appreciate the collaboration and persistence of the U.S. Corps of Engineers, the U.S. Fish & Wildlife Service, and the U.S. Environmental Protection Agency.

Sincerely,

Justin Brooks, Director of Government Relations

From:	Robert Landrum
To:	YazooBackwater MVK
Subject:	[Non-DoD Source]
Date:	Thursday, July 18, 2024 2:52:11 PM

Just wanted to make a comment because I couldn't make it to the meeting today just to let you know that we need the pumps not only to benefit the farmers but to benefit the wildlife and the beauty of the land instead of selling dead timberland all the time after a flood just do what the government promised over 40 years ago and do the right thing and put the pumps in please

From: Rose Davis
To: YazooBackwater MVK
Subject: [Non-DoD Source]
Date: Monday, July 1, 2024 10:12:03 AM

Have you seen the flooding in Minnesota? Some people are floating in their streets withh mire rain coming to the Midwest. Where do you think that water us coming? For God's sake, COMPLETE the Yazoo Backwater Project. Have you not learned anything from the six month flood of 2019? I have NO faith in USACE or any other U.S. government organization.

From: Rhonda Hendrix
To: YazooBackwater MVK
Subject: [Non-DoD Source] 2019 Backwater Flood
Date: Tuesday, August 27, 2024 10:27:53 AM

As a survivor of the 2019 Backwater Flood I support option 2 to prevent another devastating flood. The preventable 2019 Backwater flood is still taking an emotional and mental toll on me. Flashbacks occur often of the starving animals I saw. I cried many times for the slow death those animals incurred. I witnessed the loss of a tree in our backyard where eagles landed. That day was horrible as the flood water uprooted the habitat for our national bird. Six years later and the memories are vibrantly etched in my mind.

Please help the people of Eagle Lake and the Mississippi Delta. Begin option 2 immediately.

Rhonda Hendrix
Sent from my iPhone

From: Thomas Antoine
To: YazooBackwater MVK
Subject: [Non-DoD Source] Alternative 2
Date: Tuesday, August 27, 2024 1:45:36 PM

I support the proposition !

Sent from my iPhone

From: Victoria Darden
To: YazooBackwater MVK
Subject: [Non-DoD Source] Alternative 2
Date: Tuesday, August 27, 2024 8:55:57 PM

I've told you all my story about living through the backwater flood for the last 5 years now. I live at onward in issaquena county. I farm, live , and hunt there. There isn't a better place to live. The people who live in this community truly love and care about one another, the animals and the environment. You absolutely will NOT find more passionate people who want to preserve this area for the future generations than the people who ACTUALLY live here. The devastation that occurred in 2019 & 2020 is absolutely inexcusable to not only the environment, animals, and the people. We appreciate all the work that has went into resolving this problem. We will settle for alternative 2 if that's the best you can do. However, as I stated in the Vicksburg meeting I think you can do better with the cut on elevation level and cut on dates. I just hope to see progress made on this project for the older generation who is constantly aging and dying. They fought this fight long before us and deserve to see justice served . 82 years is too long. Please do whatever you can to move this process of building the pumps along. I'm at the point of begging. Please consider the residents of Ms with more regard then those form letters sent from people who weren't here to witness the destruction of the flood for themselves. Let's fix this environmental injustice once and for all!

#finishthepumps

Victoria Lyn Darden

From: Peggy Sellars
To: YazooBackwater MVK
Subject: [Non-DoD Source] Backwater project
Date: Tuesday, August 27, 2024 3:22:05 PM

We support option number two.
We have went Way beyond enough now please get this done.

George and Peggy Sellars

From:	Sara Marie Panetta
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Backwater Pumps Alternative 2
Date:	Tuesday, August 27, 2024 9:47:19 PM

I helped families during the flood in 2019. I witnessed animals die and land wash away where homes were built. It's time to finish the project. I support alternative 2.

Sara Marie Klaus
Madison MS

From: rick daughtry
To: YazooBackwater MVK
Subject: [Non-DoD Source] Comment submitted from website for Yazoo Backwater
Date: Saturday, August 24, 2024 6:16:40 AM

Finish what was started long time ago. Other states have pumps

Sent from Yahoo Mail for iPhone

From: rllccy117@gmail.com
To: YazooBackwater MVK
Subject: [Non-DoD Source] Comment submitted from website for Yazoo Backwater
Date: Thursday, July 11, 2024 9:01:46 AM

The flood was devastating for a lot of people that didn't deserve any of it. My family's homestead was flooded and had to remodel the family home. My sister & her family live in that home now. The pumps need to be completed so the flooding never happens again to disrupt people's livelihoods. The wildlife was displaced just like the families that live there. Please finish the pumps!!
Sent from my iPhone

From: megldp
To: YazooBackwater MVK
Subject: [Non-DoD Source] comments regarding the pumps
Date: Wednesday, July 24, 2024 11:19:39 AM

Good morning,

I attended several of the public meetings over the past several years regarding the Yazoo Backwater Pumps and I believe the residents of the area have covered every reason in the world as to why we need the pumps. And yes, those that don't live here and have never seen the reality of what can happen when a back water flood does occur, have stated their opinion as well and most of those should be considered irrelevant in my opinion.

Bottom line - not having the pumps - a promised part of the flood control plan from the 1940s, and the only part never completed, is bad for the Economy, Businesses, Housing, Residents, Wildlife, Flora and Fauna of the South Delta.

The 2019 flood decimated the economy of the South Delta. Agriculture is what drives this area, and when farmers can't farm, it trickles down and everything is affected.

Businesses closed as a result of the flood.

Homes were ruined as were roads

Residents moved away

Wildlife was killed and has still not rebounded to pre flood populations even today 5 years later - from black bear (a threatened species) to white tailed deer to squirrels to butterflies and other insects. - all of the food chain was affected.

Invasive species and all manner of contaminants were spread all over the landscape through the flood, and much of this changed habitats forever.

As far as wetlands go - The wetlands here have historically been seasonal wetlands, wet during the winter/spring season, and drying up summer, fall - for the most part. However, in 2019 the wetlands and other flooded areas were full from December through August in many places. While species and flora and trees may be accustomed to the seasonal floods, this extended wet season was not beneficial to them. Trees have died and are still dying today as a result of so much water over such a ong period of time - and hot water at that in June, July and August. I was in Delta National Forest in a boat in July of 2019 - it was eerily silent - no birds because there was no available food for them, and roads I've driven in the past were under 6+ feet of water. Since that time I've seen so many trees die and fall, a lot of weeds and growth where there once was none - due to movement from flood and loss of canopy.
I participate in an annual NABA butterfly count each summer. We've still not had a count that reached preflood numbers, again loss of habitat and host plants. But trust me - the forest is still a seasonal wetland. Turning on the pumps WILL NOT destroy any wetlands - that's ridiculous.

I am in favor of alternative #2 and please Finish the Pumps!

Meg Cooper, South Delta Resident

From:	tcshelton0228@gmail.com
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] DEIS Comments - Yazoo Backwater Area Water Management Project
Date:	Thursday, July 25, 2024 11:02:34 AM

I am a retired Corps employee who worked for many years at the Vicksburg District and finished my career at the Mississippi Valley Division Office. I was a Civil Engineer in Construction Division when the outlet channel for the pumping plant was constructed in the 1980's and after moving to Project Management, I was heavily involved in the project reformulation in 2007. So, I am very familiar with the purpose and history of this project.

I have lived in Vicksburg all my life and am painfully aware of the devastation caused by floods in the lower Delta going back to the Flood of 1973. I have friends who live, work and farm in the South Delta, so I know how the floods have impacted them, especially the horrific flood of 2019 which kept the area under water for many months. My wife and I helped friends at Eagle Lake clean up the mud and filth that covered their property in August 2019. I have attended most of the public meetings that have been held over the past couple of years and have heard the passionate comments from many residents whose lives and livelihoods have been affected by the floods.

I fully support construction of the proposed 25,000 cfs pumping plant and believe that Alternative 2 would be the best long-term solution to the water management problems in the South Delta.

Sincerely,

Tommy Shelton
131 Woodstock Drive
Vicksburg, MS 39180
601-415-2507

From:	Ricky Smith
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Eagle Lake Flooding
Date:	Tuesday, August 27, 2024 3:18:03 PM

Sent from Yahoo Mail for iPhon

The pumps are much needed in the Mississippi Delta. I support option 2.
The 7 months of flooding in 2019 destroyed my mobil home and numerous trees.
This project is entirely overdue!!

Ricky Smith
Eagle Lake MS. Vicksburg
601 757 5406

Sent from Yahoo Mail for iPhone

From:	Ricky Smith
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Eagle Lake Flooding
Date:	Tuesday, August 27, 2024 12:10:52 PM

The pumps are much needed in the Mississippi Delta. The 7 months of flooding in 2019 destroyed my mobil home and numerous trees. This project is entirely overdue!!

Ricky Smith
601 757 5406

From:	rob neblett
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Finish the Pumps.
Date:	Tuesday, August 27, 2024 4:46:41 PM

Hello, my name is Rob Neblett. I own approximately 1000 acres along the banks of Steele bayou 2 1/2 miles north of the lock. I cannot emphasize the importance of getting this project finished. It would help prevent devastating floods that have completely wiped out the wildlife and damaged thousands of acres of crop land. No one would even believe the bones that I witnessed piled up for miles after the 19 flood. It will be many years before several species recover. Seasonal floods are understandable but the locks would at least prevent the catastrophic flooding that took place those two years if a pump system was allowed in place. I hope whoever is in charge will consider the thoughts and opinions of those that have actually seen it and lived it not just read it from 1000 miles away. Thank you for your consideration.

Rob Neblett
601-506-9148
Sent from my iPhone

From: Todd Monsour
To: YazooBackwater MVK
Subject: [Non-DoD Source] FINISH THE PUMPS
Date: Tuesday, August 27, 2024 10:45:22 AM

FINISH THE PUMPS
Thanks,

Todd Monsour

From: Paul Dees
To: YazooBackwater MVK
Subject: [Non-DoD Source] finish the pumps
Date: Friday, June 28, 2024 1:35:29 PM

I would like to be on record as fully supporting the Yazoo Backwater pumps.

Regards,
- Paul D. Dees

http://www.greenlandplantingco.com

From: Peter Scott
To: YazooBackwater MVK
Subject: [Non-DoD Source] In favor of option 2
Date: Tuesday, August 27, 2024 4:57:38 PM

Lived in the lower Mississippi delta region for 8 years. Adamantly support option 2 for the pumps.

Thank you.
Pete Scott
Sent from my iPhone

From:	Peter Nimrod
To:	YazooBackwater MVK
Cc:	Renacker, George M (Mike) CIV USARMY CEMVK (USA)
Subject:	[Non-DoD Source] MS Levee Board comments on the YBW Project Draft EIS
Date:	Friday, August 23, 2024 10:34:42 AM
Attachments:	MS Levee Board official comment letter to Corps on the YBW Project Draft EIS (August 23, 2024).pdf

Mike Renacker,

The Mississippi Levee Board wants to thank the U.S. Army Corps of Engineers (Corps), the Environmental Protection Agency (EPA), and the U.S. Fish & Wildlife Service (USFWS) for working together to come up with a solution for our Backwater Flooding problem! **We prefer Alternative 2 with a 25,000 cfs Pumping Plant that turns on at 90' starting March 16th each year.** Both Alternatives 2 and 3 will protect people, homes, roads, farms, infrastructure, wildlife, fish, trees and the environment. The Federal Family of the Corps, EPA and USFWS have worked together to develop this brand new project for the South Delta. This project is compliant with the Clean Water Act and meets the needs of the community.

Alternative 1 is no action, do nothing, in other words keep letting the area flood. This Alternative 1 has absolutely no support! We have been living with the "do nothing" plan for 83 years and we have seen the devastation to the economy, infrastructure, homes, lives, crops, wildlife, trees and the environment. **Alternative 1 is not an option!**

Alternative 4 is the nonstructural only plan. This Alternative 4 has no local support. Another problem with this Alternative 4 is that is only takes care of structures and land that was flooded in 2019. In 2019 the backwater reached 98.2'. This is the 35-year flood. The 100-year flood is 100.5'. At a minimum this Alternative 4 should take care of all the structures and land in the 100-year flood - not a 35-year flood. The major objection to Alternative 4 or any other fully nonstructural plan is that it does nothing to protect the wildlife, trees and environment. These resources will continue to die and the eco-system will further decline with a nonstructural alternative. There are several national environmental groups that have historically opposed the project and have created a "click and send" form letter email that goes directly to the Corps. They use a short introduction overview full of misleading information to incite their members and they encourage them to "click and send" these emails to oppose the pumps and support the nonstructural Alternative 4. They will send tens of thousands of mass emails to the Corps. Please note that these emails will come from all over the United States and that these people do not know the facts and they have no idea where the Yazoo Backwater Area is located. Please dismiss these emails as a mass campaign to sabotage the Pumps. **Alternative 4 is not an option!**

During the Virtual Public Meeting held July 16th there were 10 comments in the chat box - all 10 supported the 25,000 cfs pump and all 10 specifically wanted Alternative 2. During the Public Meetings held in Rolling Fork, MS on July 22nd there were 35 people who made statements. All 35 supported the pump and 24 specifically wanted Alternative 2. During the Public Meetings held in Vicksburg, MS on July 23rd there were 34 people who made statements. All 34 supported the pump and 28 specifically wanted Alternative 2. When you total up all these statements you had **79** people who made statements. All **79** supported the pump and **62** specifically wanted Alternative 2. **During the virtual meeting and all the public meetings the support for the 25,000 cfs Pump was unanimous!**

The local community wants the 25,000 cfs pump that will protect to 90' during the crop season and 93' during the non-crop season. Alternative 2 and Alternative 3 are the only options!

We prefer the earlier turn-on date of March 16th because we have an agricultural-based economy here in the Mississippi South Delta. Even if you are not a farmer, a lot of jobs and businesses in this area depend on farming to make a living. But we also understand that in the past 46 years the pumps would have only cut on before March 25th 6 times to maintain 90' (1994, 1997, 2016, 2018, 2019 & 2020). That averages to be only once in every 7 years. Historically, the vast majority of backwater floods reaching 90' happen in the April/May timeframe.

We want the required mitigation lands to be obtained voluntarily as a <u>reforestation easement</u> instead of only in fee title. A few landowners might want to sell their land but the vast majority will only want an easement. I do not think the Government wants to acquire a bunch of little tracts spread out all over the place - it would be impossible to manage. Plus when the Federal Government buys property - the counties stop receiving annual taxes on it. Let the property owner keep the property and that way they can enjoy the recreational opportunities, maintain it, and still pay taxes to their respective counties.

We want to change "mandatory" acquisition of all structures (101 structures) below 90' to "voluntary" acquisition. I can't believe there is anyone living in a house below 90' - especially when we have seen 90' 22 times since 1979. Also we reached 95.2' or higher 3 years in a row in 2018, 2019 & 2020! But if there is anyone living in a house below 90' then give them an option to buy them out or let them stay and help protect them.

This project is an Environmental Justice project! 71% of the population is minority and 30% live below the poverty line. This project will help our minority and impoverished community.

The Steele Bayou Drainage Structure was completed in 1969 and is now 55 years old. The top of the Steele Bayou Structure curtain wall is 108.5' msl. In the next few years we will be raising the Yazoo Backwater (YBW) Levee up from 107' msl. The authorized grade for the YBW Levee is 112.8' msl. Since the Steele Bayou Structure is older than 50 years and modifications will have to be made to it when we raise the YBW Levee we request that the superstructure being built for the 25,000 cfs Pumping Plant includes a gravity flow drainage structure capable of passing 50,000 cfs and is built above 112.8' msl.

We request that the Final EIS contain all the data and results of the Recommended Plan going forward. For instance, the current 100-year flood for the area is 100.5' and with the implementation of the 25,000 cfs pump it will drop the 100-year flood to 93.5'. This is very relevant data that shows the real and direct positive impacts of the Recommended Plan.

Most people looking at a 1,000 page EIS usually only read the Executive Summary found in the beginning of the document. We found the Draft EIS Executive Summary to be lacking. In fact, we found that the Draft EIS Conclusion (Section 9) located at the very end of the Main Report to be more helpful than the Executive Summary! Knowing that 99% of the population will only look at the Executive Summary in the Final EIS we ask that you do a good job in briefly and clearly explaining the details of the Recommended Plan. Please include the mitigation requirements and list the impacts, pertinent facts and data in this Final EIS Executive Summary.

The Mississippi Levee Board appreciates this Draft EIS and we look forward to the Final EIS and the signing of the Record of Decision. This project is the result of a promise made by the Federal Government 83 years ago in 1941. **Please move forward with completing the Environmental Documentation so we can start construction as soon as possible so we can Finish the Pumps!**

Peter Nimrod
Chief Engineer
MS Levee Board
P.O. Box 637
Greenville, MS 38701
(662)334-4813
peter@msleveeboard.com

BOARD OF
MISSISSIPPI LEVEE COMMISSIONERS
KENNETH RODGERS, PRESIDENT
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GREENVILLE, MISSISSIPPI 38702-0637
662-334-4813
662-332-6732
FAX# 662-378-9592
WEB PAGE www.msleveeboard.com

August 23, 2024

Vicksburg District, USACE
Attn: Mr. Mike Renacker
4155 Clay Street
Vicksburg, MS 39183

Re: Comments on the Yazoo Backwater Project Draft EIS

Dear Mr. Renacker,

The Mississippi Levee Board wants to thank the U.S. Army Corps of Engineers (Corps), the Environmental Protection Agency (EPA), and the U.S. Fish & Wildlife Service (USFWS) for working together to come up with a solution for our Backwater Flooding problem! **We prefer Alternative 2 with a 25,000 cfs Pumping Plant that turns on at 90' starting March 16th each year.** Both Alternatives 2 and 3 will protect people, homes, roads, farms, infrastructure, wildlife, fish, trees and the environment. The Federal Family of the Corps, EPA and USFWS have worked together to develop this brand new project for the South Delta. This project is compliant with the Clean Water Act and meets the needs of the community.

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BOARD OF MISSISSIPPI
LEVEE COMMISSIONERS

Peter Nimrod, P.E., P.L.S.
Chief Engineer

From:	Paul Banchetti
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] My Vote: Alternative 2
Date:	Monday, August 26, 2024 3:49:10 PM

I was out of town and therefore unable to attend the recent meetings on the subject in person. I did, however, view the Vicksburg meetings afterward on line.

I live at Eagle Lake, north of Vicksburg, and experienced first-hand the devastation of the 2019 backwater flood. A flood, by the way, that was largely not publicized nationally, in stark contrast to a flash flood, or day-long flood event which may occur in other areas of the United States. We were unable to drive to/from our house for months, forced to vacate, and then make repairs to my property that were required as a result of having approximately two feet of water around our home for several MONTHS. I am now 73 years old, and still suffer pain in both my hands that is a direct result of filling, hauling and placing thousands of sandbags in a losing effort to protect my and others' property.

My career was primarily as a Project Manager in private industry for corporate capital projects, many of which were for many millions of dollars. I can safely say that if the corporation approved $X to implement a project that consisted of three necessary components, and I only completed two of them, I would have been terminated. That is basically what the Corps of Engineers has done as it pertains to the Yazoo Backwater Project. We have the levees and the control structure in place, but now, some forty-five years later, we still do not have the third required component - the pumps. The other similar flood control projects around the United States all have the three components, but not us! (As an aside, I learned in my project management training that doing nothing is not an alternative at all.)

I now feel compelled to check the USCE river level predictions EVERY DAY from fear of another 2019. Thank God we haven't experienced one although 2020 was a rough year as well. We did lose several neighbors as a result of 2019.

I was able to attend previous meetings here in Vicksburg and other locations such as Rolling Fork. I keep hearing " we're studying the situation", which is somewhat encouraging, but it's time to "get off the pot" as the old saying goes. I realize you are required to perform such studies, but c'mon, I want to see some physical work get started. One of the local TV stations interviewed me as we were filling sandbags one day in 2019 and asked me if I thought I would ever see the pumps. I honestly answered "no" due to my age. I don't believe I have another 16 years left. That's how long it's been since I attended my first public meeting on the subject in 2008, I believe. And I've heard that the project would not be operational for some four years if it was approved today.

Bottom line is I am in favor of Alternative 2 as the only viable option, however not necessarily tied to the dates as listed nor the turn-on/off river levels. I think that some flexibility is a must.

Sincerely,
Paul Banchetti
912 Eagle Lake Shore Rd.
Vicksburg, MS 69183

From: Robert Bailess
To: YazooBackwater MVK
Subject: [Non-DoD Source] Plan to support
Date: Tuesday, August 27, 2024 7:34:07 PM

I support alternative/plan number 2
Robert R. Bailess
Sent from my iPhone

From:	Nikki Woods
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] PUMPS
Date:	Tuesday, July 23, 2024 8:23:37 PM

> I am Nikki Woods, a lifelong resident of Holly Bluff, Mississippi. I live on Lake George, 2756 Satartia Road. My husband, Eric Woods of 17 years, and I have two children Lane,15 and Emmy,11. We love living in the country raising our children on family land beside my parents, Chuck and Gale Perry. My brother, Tre Perry also farms the land.
>
> I am here to say we desperately deserve and need the pumps. We need them ASAP. We need them to come on before it causes loss of roads used to travel back and forth to our jobs and schools, we need it for safety purposes also. As three people loss their lives in the flood waters.
>
> In 2019, March 3rd to be exact, I had to get together a few bags to move to Yazoo due to backwater flooding. I just thought we would be gone a couple weeks, but little did I know we would be gone for 19 months. It was some of the most depressing and mentally exhausting times of my 36 years. I watched my parents boat in and out to go get groceries and it took a huge toll on them mentally and physically. I saw them worried not only for themselves but for the lives of myself and my brother. All because we were trapped. Loss of use of homes, land, income.
>
> In May of 2019, Eric and I decided to buy a camper to live in so my children could be near my parents because they keep them in the summer while we work. We moved it to our friends place in Holly Bluff from May to August 6th, 2019. We were finally able to move back to our own property. At this time, we struggled with mortgage company to get the insurance money to start rebuilding our home. On top of that, we needed to elevate our home as well. $48,000 was what we needed and after so much loss we didn't have this kind of money to come up with. Insurance programs offer $30,000 but after the the work is complete they reimburse you up to $30,000. Luckily, with the help of the bank we were able to start elevation in December 2019.
>
> In January 2020, the river was back on the rise. My home literally was on a few wooden casings and the house mover feared it would not hold due to rising waters. So there again we had to pack up the camper and head back to Holly Bluff, leaving our home not knowing what was going to happen.
>
> March 2020, COVID hit. Boy did this hit hard. Not only did this cause even more mental heartache. Supplies and shipping came to a quick halt. I can remember Easter vividly that year. A terrible storm hit. I remember feeling alone, scared, and helpless. I couldn't be with family due to exposure to Covid, as I am a nurse. I didn't want to expose my parents to this deadly disease but I so badly needed someone.
>
> June 2020 the elevation of my home was complete. I ended up refinancing my home through a local bank and with their guidance on how to get my insurance money, we were able to start on our home. Finally, in October 2020 we were able to move back HOME!
> God was holding us up through all the storms!
>
> With all that I have recounted above. I had no idea this all could have been lessened if we had pumps. Please move forward with the pumps ASAP! I know there are many stories out there that say the same. Listen to these stories and FINISH THE PUMPS.
> Thank you for your time.
>
> Sincerely,
> Nikki Woods
> 662-590-2169

From: Robert Royal
To: YazooBackwater MVK
Subject: [Non-DoD Source] Pumps
Date: Wednesday, July 24, 2024 8:39:38 AM

Hello

I live and farm on the northern fringe of the area that flooded in 2019. I filed a prevented planting crop insurance claim on 100 acres of my low lying land that year. It was the first such claim for me as a farmer. That expense to the crop insurance company and the loss of revenue to me because I was unable to produce a crop on that land could have been avoided had the flood control pumps been in place. Mine was just a tiny expense, though, compared with the losses on the farms, forrests, and the wildlife in the main flood area. The economics of installing pumps to avoid such losses is solid. I ask you to please focus your efforts on completing the pumps project.

Thank you
Robert Royal

From:	Meta Klaus
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Pumps
Date:	Tuesday, August 27, 2024 9:29:45 PM

I support Alternative 2 in your opinions in dealing with the devastating floods affecting the Delta region. Thank you.
Meta Klaus
Sent from my iPhone

From:	Michele McMahon
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Re: Yazoo Backwater - finish the pumps
Date:	Tuesday, August 27, 2024 9:17:20 PM

Alternative 2 please!

Sent from my iPhone

> On Jul 23, 2024, at 9:20 PM, Michele McMahon <michelewill99@yahoo.com> wrote:
>
> We own property on Eagle Lake Shore Road. We would love to build on this land for our children and Grandchildren to enjoy. We would use this as a second home for recreational purposes. It's hard to invest in something that is unknown. If we knew the pumps would be installed it would make this decision much easier. I also know that there are families that livelihood rests in the decision to finish the pumps. It's a shame that this has lingered for so long. My hope is that a decision will be made and work will begin sooner than later.
>
> Thanks for caring!
> Michele McMahon
> 3530 Eagle Lake Shore Rd
>
> Sent from my iPhone

From: Marsha Tapscott
To: YazooBackwater MVK
Subject: [Non-DoD Source] Support of Option 2
Date: Tuesday, August 27, 2024 8:11:40 PM

As a Mississippi resident I do not understand why flood control projects were completed in every other state but Mississippi. The states with pumps did not suffer the devastation that occurred here in 2019 or threatened in 2020.

Two of the three counties affected are the two poorest counties in Mississippi. The third county, Warren County, serves as a resource for food, health care and employment. During the flood of 2019, the residents of Sharkey and Issaquena were cut off from things that have a direct impact on quality of life. These hardships won't be isolated events as the effects of global warming continue to impact our environment with extreme weather conditions.

The 2019 flooding had a negative impact on the area wildlife as well. The food needed by ducks, deer, bears and other animals was under water for up to six months. Fortunately, the flooding in 2020 did not reach the levels that were experienced in 2019.

It's time to stop this undue stress for God's creatures whether they are human, animals or fowl.

The installation of pumps and earliest starting date for pumping are imperative for the survival of the Mississippi Delta. Option 2 is the best solution to protect the MS Delta's infrastructure, wildlife, agriculture, workforce, access for emergency services, medical care and quality of life for residents - and to ensure that this prolonged manmade tragedy does not occur again.

Marsha Tapscott
Tupelo, Mississippi
marshatapscott@yahoo.com

From:	Mary Mccormick
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] The pumps
Date:	Wednesday, July 3, 2024 10:14:04 AM

The South Delta is not expendable. The USA needs our crops, our wildlife, our people. Stop listening to professional so-called environmentalists who have never lost a year of crops, worn waders inside their homes, watched wild animals starve day by day, or smelled the inescapable stench of rotting wildlife and native vegetation that they claim to care about. Backwater flooding is not a natural disaster threat. It's 100% manmade. And the remedy must be 100% manmade. After almost a century of federal mismanagement, IT'S TIME to FINISH The PUMPS!

As a child I road the turn rows of my grandfather's land near Steele Bayou in Issaquena County. I watched him clear it, cultivate it, and harvest from it in the 1950s. I now am trustee and lease it to good stewards of this rich land that has had fallow years due to flooding.

Environmental scientists have now verified what the folks living here have been saying for generations. Maybe you'll now listen to them instead of the environmental groups who distort and misrepresent the situation to pocket millions of dollars in contributions from gullible donors.

Please protect our South Delta wildlife, our woodlands, our rich soil and livelihoods. Please keep your promise made 90 years ago. Install that last pump.

Mary Dayle McCormick, Trustee
Scudder Langford Family Trust
Issaquena County, Mississippi

From: Nancy Clements Gentry
To: YazooBackwater MVK
Subject: [Non-DoD Source] Yahoo Backwater Project
Date: Tuesday, August 27, 2024 11:50:32 AM

As a resident of Mississippi (or former resident) I'm writing to support Option 2 with the completion of the pumps that were included in the original flood control plan from 1941. The early start date for initiating pumping offers the best scenario for local agriculture, wildlife and quality of life for delta residents. A flood control plan that was implemented to protect the state from river flooding should not endanger the state due to trapped water behind the incomplete structures. The 2019 prolonged flood and devastation to our state should not be allowed to happen again.

I was born and raised in Mississippi and though not a resident of the MS delta, have direct knowledge of the impact and damage our state suffered during the prolonged backwater flood of 2019. I have family that lives in that area and watched the physical, mental and financial suffering that they endured because the pumps were not installed as designed. Please finish this project as designed. I support Option 2 as the best alternative for the MS delta and our entire states economy.

As a Mississippi resident I do not understand why flood control projects were completed in every other state but ours. Those states did not suffer the devastation that occurred here in 2019 or threatened in 2020. The installation of pumps and earliest starting date for pumping are imperative for the survival of the Mississippi Delta. Option 2 is the best solution to protect the MS Delta's infrastructure, wildlife, agriculture, work force, access for emergency services, medical care and quality of life for residents - and to insure that this prolonged man made tragedy does not occur again.

A giant bathtub was created in the Mississippi Delta with the implementation of the 1941 flood management plan without the completion of an emergency overflow. I'm glad to see that the EPA and the USACE are working together to remedy and prevent future backwater flooding. Option 1, doing nothing, and buy outs are not the answer. The answer is finish the pumps! Option 2 in my opinion provides the best timeline for farmers and residents to negate the impact of spring flooding and prevent the 6 months of devastating flooding of 2019 from happening again.

My family suffered physically, emotionally and financially from the prolonged flooding that occurred due to the lack of pumps and incompletion of the Yazoo Backwater Project. I'm writing to support Option 2 as the best solution provided by the EPA and USACE in preventing this disaster from happening again.

The devastation from backwater flooding in 2019 should not have occurred and should be prevented from happening again. The damage to the environment, wildlife and infrastructure can still be seen today. My family suffered physically, emotionally and financially from the prolonged flooding that occurred due to the lack of pumps and incompletion of the Yazoo Backwater Project. I support Option 2 as the best solution provided by the EPA and USACE to save the Mississippi Delta and our states economy.

Nancy Clements Gentry
Sent from my iPad

From: Robert Pogue
To: YazooBackwater MVK
Subject: [Non-DoD Source] Yazoo back water
Date: Saturday, June 29, 2024 8:23:27 AM

We did live in Holly Bluff until 2019 and the flood took everything we had our trailer and everything in it and other people did too they need the pumps put in you are more worried about the birds people are losing their homes and businesses and wild animals are died because you will not put the pumps in if you would have lost your home then you would know
Sent from my iPhone

From:	Michele McMahon
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Yazoo Backwater - finish the pumps
Date:	Tuesday, July 23, 2024 9:21:07 PM

We own property on Eagle Lake Shore Road. We would love to build on this land for our children and Grandchildren to enjoy. We would use this as a second home for recreational purposes. It's hard to invest in something that is unknown. If we knew the pumps would be installed it would make this decision much easier. I also know that there are families that livelihood rests in the decision to finish the pumps. It's a shame that this has lingered for so long. My hope is that a decision will be made and work will begin sooner than later.

Thanks for caring!
Michele McMahon
3530 Eagle Lake Shore Rd

Sent from my iPhone

From: Martin Hendrix
To: YazooBackwater MVK
Subject: [Non-DoD Source] Yazoo Backwater Flood
Date: Tuesday, August 27, 2024 1:27:30 PM

My name is Marty Hendrix and was a resident at Eagle Lake during the prolonged flood event during 2019 and again suffered property damage during the flooding in 2020.
I support option two.

Sincerely

Marty Hendrix
Sent from my iPhone

From:	Nancy Clements Gentry
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Yazoo Backwater Project
Date:	Tuesday, August 27, 2024 6:42:34 PM

As a resident of Mississippi (or former resident) I'm writing to support Option 2 with the completion of the pumps that were included in the original flood control plan from 1941. The early start date for initiating pumping offers the best scenario for local agriculture, wildlife and quality of life for delta residents. A flood control plan that was implemented to protect the state from river flooding should not endanger the state due to trapped water behind the incomplete structures. The 2019 prolonged flood and devastation to our state should not be allowed to happen again.

I was born and raised in Mississippi and though not a resident of the MS delta, have direct knowledge of the impact and damage our state suffered during the prolonged backwater flood of 2019. I have family that live in that area and watched the physical, mental and financial suffering that they endured because the pumps were not installed as designed. Please finish this project as designed. I support Option 2 as the best alternative for the MS delta and our entire states economy.

As a Mississippi resident I do not understand why flood control projects were completed in every other state but ours. Those states did not suffer the devastation that occurred here in 2019 or threatened in 2020. The installation of pumps and earliest starting date for pumping are imperative for the survival of the Mississippi Delta. Option 2 is the best solution to protect the MS Delta's infrastructure, wildlife, agriculture, work force, access for emergency services, medical care and quality of life for residents - and to insure that this prolonged man made tragedy does not occur again.

A giant bathtub was created in the Mississippi Delta with the implementation of the 1941 flood management plan without the completion of an emergency overflow. I'm glad to see that the EPA and the USACE are working together to remedy and prevent future backwater flooding. Option 1, doing nothing, and buy outs are not the answer. The answer is finish the pumps! Option 2 in my opinion provides the best timeline for farmers and residents to negate the impact of spring flooding and prevent the 6 months of devastating flooding of 2019 from happening again.

My family suffered physically, emotionally and financially from the prolonged flooding that occurred due to the lack of pumps and incompletion of the Yazoo Backwater Project. I'm writing to support Option 2 as the best solution provided by the EPA and USACE in preventing this disaster from happening again.

The devastation from backwater flooding in 2019 should not have occurred and should be prevented from happening again. The damage to the environment, wildlife and infrastructure can still be seen today. My family suffered physically, emotionally and financially from the prolonged flooding that occurred due to the lack of pumps and incompletion of the Yazoo Backwater Project. I support Option 2 as the best solution provided by the EPA and USACE to save the Mississippi Delta and our states economy.

Nancy Clements Gentry
Sent from my iPad

From: Ricky Flynt
To: YazooBackwater MVK
Subject: [Non-DoD Source] Yazoo Backwater Project Support
Date: Tuesday, August 27, 2024 11:55:44 AM

Please accept this email as my support for the completion of the Yazoo Backwater Pump project in Mississippi. Please provide all financial support necessary to complete the project as promises possible. The natural resources and the communities of the vicinity are in desperate need of help to help reduce the exaggerated flooding conditions that are destroying our forests, wildlife habitats, agriculture, and economy of the area.

Ricky Flynt
503 Rusk Dr.
Brandon, MS 39047

Ricky Flynt - Sent from my iPhone

From: Michael Hughes
To: YazooBackwater MVK
Subject: [Non-DoD Source] Yazoo Backwater Pumps
Date: Wednesday, July 24, 2024 6:36:23 AM

Good morning,

I’m reaching out regarding the Yazoo Backwater Pumps. My family has lived in Yazoo City for a very long time - since the early 1900s. We have owned and operated a local business for 40+ years from my grandfather and now my father. The flooding that has occurred in years past has affected all people in the area including my family. If farmers in the area aren’t making any money, then they aren’t spending any money. If farmers aren’t farming, then anyone associated with a farmer isn’t making any money or spending any money. Restaurants, grocery stores, construction companies, the list goes on.

I vote to support option 2.

Thank you,
Michael Hughes

From: Rainer Roberts
To: YazooBackwater MVK
Subject: [Non-DoD Source] Yazoo Backwater Pumps
Date: Tuesday, July 23, 2024 9:17:18 AM

Good morning,

My name is Rainer Roberts. I am from Yazoo county and I have lived next to the Yazoo River levee for 23 years. I come from a long line of farmers and every one of my closest friends works in agriculture. I have seen first hand how devastating the backwater floods can be to family's that I hold near to my heart. I have also seen what it does to the local wild life. The wildlife in my area are displaced greatly every time the water rises. It has pushed wild hogs into the hills and stranded deer on any dry land to the point of starvation. The Mississippi Delta needs these pumps.

From: gdiffey@aol.com
To: YazooBackwater MVK
Subject: [Non-DoD Source] Yazoo Backwater, some thoughts
Date: Saturday, July 13, 2024 9:46:18 AM

To whom it may concern,

I would like to encourage this group to go ahead and build the pumps. Here in Anguilla, MS, in Spring of 2019, I personally witnessed the difference having pumps on the Louisiana/Arkansas side of the river and the lack of pumps on the Mississippi side makes. I share some observations here.

The most obvious is the way the river rose over farmland and homes, destroying homes, making travel to and from the homes left difficult or impossible. The water made it impossible for so many acres to be planted. I don't farm, but rent out some small number of acres, and the only rent I received that year was a small percentage of the small insurance payout that my renter received. That affected my bottom line and, of course, the farmer's. Many acres in the area were underwater so late that farmers were unable to plant, so they were even unable to receive insurance payments. They suffered badly.

Another point that was really agonizing to witness was the negative affect on the wildlife and the vegetation. This should be of particular interest to groups that claim interest in the environment. Trees whose trunks and roots were under water for a long time died. Where the ground got spongy, some trees fell over for lack of support to their roots. At the time I had to travel north in the early mornings and saw many wild animals, deer, oppossum, raccoons, etc, running in the highway to get out of the water because the highway was higher ground. Of course, many were hit by vehicles. This was even worse going south towards Vicksburg, since the water was deeper and more widespread there. We also observed that many animals were skinny and starving since their source of food was under water or unplanted. I feel sure that if people and organizations who are concerned about wildlife had seen the devastation that year, they would realize the need of the pumps for the protection of the environment. They would see that withholding the pumps had the opposite effect that they support.

Thank you for hearing my concerns and my thoughts on the need for the pumps. I hope that you will come around to seeing the need to complete this project.

Sincerely,
Rebecca Touchstone Diffey

From:	Sheila Ashley
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Yazoo Backwater
Date:	Friday, June 28, 2024 10:09:50 PM

The picture shown on this website is showing my family land. There was a time when my grandfather made a living off this land and very rarely it flooded. Because of the pumps it floods regularly now and we are lucky to make $3k off the land now farming it. It is detrimental to the family! Pumps! Pumps! Pumps!

Sheila Ashley
Sent from my iPhone

From: Paige Adcock
To: YazooBackwater MVK
Subject: [Non-DoD Source] Yazoo Pumps--Alternative 2
Date: Tuesday, August 27, 2024 10:42:09 PM
Attachments: Comments EIS 7.22.2024.docx

Letter Attached

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Paige Adcock, CPA
P.O. Box 26
Yazoo City, MS 39194
(662) 571-7128
cpapaige@gmail.com

Paige Adcock, CPA
P.O. Box 159
Holly Bluff, MS 39088
(662) 571-7128

July 22, 2024

Mr. Mike Renacker
Vicksburg District, US Army Corps of Engineers
4155 Clay Street
Vicksburg, MS 39183

Dear Mr. Renacker,

I am sixty-one years old and live in my childhood home, which my grandparents built. My grandfather purchased our farm in the late 1940s after the passage of the Flood Control Act of 1941, which assured the Yazoo Backwater Area protection from catastrophic flooding at elevations of 90' and above. All of the land he purchased is above that elevation. When the Holly Bluff cutoff was conceived, plans placed the canal right in the middle of my grandfather's fields, forcing him to give up fifty acres of his cropland. While he never relished the idea of losing land, he understood the value of good drainage to the whole MS Delta and believed it was honorable to make this sacrifice for many affected to have a better life. For that loss of land use, my grandfather was reasonably compensated. He realized he might not live to see the entire project completed but was confident his sacrifices would pay off for his children and grandchildren when the project was completed as promised. He died in 1960 at fifty-four years old.

The 1973 flood severely damaged our house, but my dad still managed to plant and harvest a crop on our farm. He breathed a sigh of relief when the drainage structures and backwater levees were completed in 1978 and thought we were all home-free when the contract to build the pumps was awarded in 1986 and work began. He died in 1988 at fifty-one years old. My first grandchild was born on November 30, 2019. His great-grandfather and great-great-grandfather would be incredulous at the idea that their namesake, born almost eighty years after the passage of the 1941 Flood Control Act, might be living on their land in catastrophic flooding because this project was still not completed. I'm not sure either would ever have believed it was possible to go an entire crop year without farming a single acre of their farm, as happened in 2019. We managed to save our family home from flooding through some seriously heroic levee construction measures by my husband and sons. Living for seven months completely surrounded by stagnant water is undoubtedly no vacation. Watching your neighbors lose the flood fight one by one and wondering every morning for seven months if this is the morning you will step out of bed and into floodwater is exhausting.

My middle son graduated from college six years ago and now farms with us. Upon graduation, he moved into a home near us and fixed it up as best he could without going into debt. He got married on February 8, 2019. On March 23, 2019, he and his wife came home from work to find their power had been cut off due to the placement of their electric meter near the rising water. They were forced to leave immediately but did not expect water to enter their house. Months later, their home became one of the lost causes. At this point, they were homeless and expecting a child. For the next three years, my son and his wife worked through the FEMA and insurance process on their demolished home, living temporarily in a small lakeside cabin. If I allow myself to dwell on how much this flooding situation has personally affected my immediate family, I can get quickly overwhelmed. Instead, I choose to concentrate on how to ensure the future changes for my own children and grandchildren.

I realized early in 2019 that although I had lived in this area my entire life, I had never paid any attention to flood control issues, and if I wanted to understand the process, I would have to get educated. What I have learned is that organizations like the National Wildlife Federation, The Sierra Club, Healthy Gulf, the National Audubon Society, and American Rivers have amassed small fortunes by grossly distorting facts and disseminating disinformation to their members for the sole purpose of soliciting donations with no thought for the wildlife or environment they claim to protect. While this is an appalling practice that preys on their membership, I did not expect their disinformation campaigns could infect the halls of Congress. Yet, the same prevarications highlighted in their press releases and donation solicitations appear word-for-word in the Congressional Record in speeches and comments by legislators who have never set foot in the Yazoo Backwater Area. The degree to which these so-called environmental nongovernmental organizations have been allowed to lobby Congress and the EPA based on untrue information while residents of this area lose lives, homes, and livelihoods and the very environment and wildlife these organizations profess to protect are decimated should be criminal. We, who live in the Yazoo Backwater Area, appreciate USACE's investment of time and resources to ensure accurate data and facts regarding flooding in this area are available.

The US Army Corps of Engineers, the US Department of Agriculture Farm Service Agency, and the Mississippi Emergency Management Agency have quantified the economic and environmental costs of backwater flooding, but 2019's flooding showed us there are significant REAL costs to residents of a seven-month flood that are not reimbursable. Mississippi State University developed a questionnaire to collect data that could be compiled to quantify the economic and social costs of this flood. The results are staggering. The average out-of-pocket expenses per respondent totaled over $42,000. The costs associated with increased commutes due to flooded highways and roads averaged approximately $185 per week per driver—almost $1,500 per month in a household with two working parents. Many of those affected will never recover financially. With each flood event, the Yazoo Backwater Area's population permanently decreases as flooded residents are forced to give up their homes, businesses, jobs, and hopes for the future.

While it was easy to see the devastation to homes, cropland, wildlife, businesses, infrastructure, trees, the environment, and even fish left by the 2019 flood, what you couldn't see quite as quickly was the toll that devastation took on the heart and soul of the people of this area. It's one thing to experience a disaster in the form of a hurricane or a tornado that instantly destroys your home and business, followed by shock and recovery. It's an entirely different experience when that devastation is a seven-month slow death with no real recovery followed by a brief hiatus before the next torturous flood event begins. The constant stress and worry are almost unbearable. It is as unsustainable a lifestyle for people as is the flooded environment for the wildlife. We are reaching the point that truly nothing can survive the flooding in the Yazoo Backwater Area if the pump project is not completed.

With COVID-19, the entire country experienced social distancing, business and job losses, decreased family incomes, and supply chain interruptions due to a virus that was no fault of their own. As a result, our government has authorized trillions of dollars in stimulus spending. Residents of the South Delta have dealt with these same impacts with flooding due to no fault of their own for generations. The solution was promised eighty-three years ago. Suppose we told those devastated by the economic ramifications of COVID-19 to sit tightly for eighty-three years, and perhaps we will deliver the funds promised today to your great-grandchildren? No one believes that would be an acceptable solution for COVID-19---nor is it acceptable for generations of South Delta residents who have experienced loss after loss due to man-made flooding.

I am grateful for all the Corps of Engineers and the Environmental Protection Agency have done to make this project a reality. After decades of flooding and discouragement, I am heartened by your commitment to jointly finding a reasonable, working solution for the South Delta's people and wildlife. You have patiently listened to the area's residents express their frustrations and grievances and vowed to work together to ensure they do not experience another 2019-level flooding catastrophe. While we know there will be challenges to your proposal, working jointly with all relevant governmental agencies on the front end ensures your current plan is the best it can be. I cannot imagine you have another project under the entire MS River and Tributaries Project that has been as thoroughly studied as this one. Your June 2024 Draft Environmental Impact Statement and previous studies, along with unprecedented devastation from the 2019 flood, have clearly proven the pumps are the most ecological and economical solution for the communities, wetlands, aquatics, birds, wildlife, and people of the Yazoo Backwater Area. Given the proposed Water Management Plan presented in the DEIS has 2 Alternatives, Alternative 2 makes the most sense for the agriculture industry in our area. By controlling flooding in the vast area of the Delta National Forest, our area's hunting and recreational commerce will have a chance to thrive with dependable water levels and the lack of flood-induced damage to the structures and landscape in our forestry resources. Thank you for pressing forward and working with the EPA to seek a viable solution for preserving the environment of the South Delta. You are our last hope in what has appeared to be a seriously hopeless situation for so many years. FINISH THE PUMPS!!

Paige Adcock

From:	Jay Brown
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Comment submitted from website for Yazoo Backwater
Date:	Saturday, August 24, 2024 7:10:11 AM

Install pumps like intended and planned when levees was built! Get the water out is the main focus! This should've never been an issue if it was executed when it was supposed to be in place! Now I feel the farmers and land owners should be compensated their losses for the governments neglect!

From: Ken Klaus
To: YazooBackwater MVK
Subject: [Non-DoD Source] Comment submitted from website for Yazoo Backwater
Date: Tuesday, August 13, 2024 4:10:36 PM

Sent from Mail for Windows

The management agreement for Eagle Lake is a maximum of elevation 76.9 and a yearly drawdown in the fall to 75.0. Lowering the lake is critical to sustaining the trees in the lake and to reducing lakefront property damage due to overly high stages. Operation of the Muddy Bayou Structure gates has been severely restricted to prevent Asian Carp from entering the lake.

Invasive fish species such as Asian Carp surely comes under your broad definition of ecosystem damages. Please consider including a fish-entry barrier system to the Muddy Bayou Control Structure in the ecosystem mitigation portion of the project. This barrier will allow full operation of the gates to ensure that the lake can be lowered each fall. In doing so, Eagle Lake will be protected from invasive species and flexibility will be added to managing the low water pool of the backwater. The barrier could be as simple as a bubble system run by a 250 cfm portable compressor or heavy screens placed in the slots for the stop logs.

The flooding of the lake in 2019 demonstrated the stress on the trees by killing hundreds of cypress that have thrived for 50 to 100 years or more. The high stages in the lake this year has killed several dozen more.

The lake has been maintained above the 76.9 level since March presumably to allow young fish to seek shelter among the trees. However, the stress has killed several dozen of the trees located in the deeper water. Trees that will never be replaced and form one of the key beauties of the lake. Protecting one year's fry is extremely short sighted when it causes permanent damage. Instead, the wise move is to lower the average stage of the lake for a few years to allow the stressed trees to recover.

The backwater begins flowing into Eagle Lake near Tara most likely below elevation 93. Please consider adding gates to key culverts and raise farm roads to prevent this over-land flow into the lake.

The capacity of the proposed Pump Station will allow control of the duration of floods. Please allow flexibility in your Management Plan to adjust the hardwood forests become severely stressed. Prolonged stages at 90 will kill the hardwoods. Wise use of the Pumps can prevent this.

I deeply appreciate the efforts of this team and your willingness to take time to meet with us.

Sincerely, Ken Klaus, Eagle Lake, MS

From:	Ken Klaus
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Comment submitted from website for Yazoo Backwater
Date:	Tuesday, August 13, 2024 3:52:14 PM

Thank you for your collaboration to produce the report.

The 2019 Flood demonstrated that without a pump station, 70 percent of the wildlife will die along with severe damage to trees and habitat, along with a gut punch to the quality of life of all inhabitants.
The high turn-on elevation of 93 in March will increase the probability that heavy rains will cause higher peak elevations and extended days or weeks to pump down to 90. With wetter years in the forecast, the repeated years of higher stages may devastate the hardwood forests that dominate the lower portion of the basin.
Please consider designing the pump intakes to be able to pump at elevation 87 to provide the capability to alter the management plan if lower levels are required to reduce stress to the forests.
Please revise the authorization language to include the flexibility to adjust the turn-on dates and elevations.
While I choose Alternative 2, repeated years of flooding may demonstrate that earlier and lower turn-on levels are warranted.

Ken Klaus
Eagle Lake, MS

From:	Marsha Barber
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Comment: 17875 Hwy 465 (Eagle Lake area)
Date:	Wednesday, July 3, 2024 12:19:58 PM

From Jimmy & Marsha Barber.
17875 Hwy 465, Vicksburg, MS. 39183.
Eagle Lake is first about the kind and helpful people and next all about the very generous natural beauty of its expansive environment. Wildlife, flora, and fauna here are abundantly enjoyed despite repeated past flood events. During the floods, though we lived elsewhere, we knew the people here withstood the stress and hardship of repeated flood-induced personal health issues, suffered humane treatment from outsiders looking in, feared for their safety, and suffered undue financial burdens. We always found ourselves just shocked to disbelief of the opposition from the government and from several groups that promoted decisions of hurtful nature to human life and happiness of the people who are overly affected by the repeated flooding. Shameful actions have been made towards humans who work, and pay for the right to have a life lived in peace.
We had a strong desire to live the Mississippi delta life, and still remain near the interstate, air, train, and other means of transportation in our retirement years. The Eagle Lake area is and provides all of these things.
In October, 2020 we purchased this home and property in the Eagle Lake / northwest Warren County community as our new full time residence. We are fortunate to have found a home situated inside the Brunswick levee area, which has prevented the house structure from flood damages in 2019 and prior flood years. The land and buildings we have on the lake side of the Brunswick levee, however, did have serious water erosion damage from floods (suffered and repaired by the previous owners). Obviously we never want to find ourselves being affected by any flooding. We seek to fully support doing the right thing of building the extremely overdue and overlooked structures to alleviate major long term flood damage in the Mississippi Delta. We support correcting the many past wrongs. This pump structure is right, it is doable, and it is expected and anticipated by everyone of us who desire an end to being ignored by they whose job it is to make sound honest humane decisions.

From:	Luke Richards
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Comments on the pumps: Luke Richards
Date:	Sunday, July 7, 2024 10:04:35 PM

This is Luke Richards from Yazoo City, MS I work in the south MS Delta as a Crop Consultant around Rolling fork and Humphreys county. I grew up out on Wolf Lake which is between the Whittington Channel and the Yazoo River so not in the area being discussed but most of my career is in the backwater area. I fully support the pumps and we need them if we want to have any economic future in the area.

To change the subject slightly I am only 24 years old and have experienced 5 floods that got in my parents house (08, 11, 15-16, 18-19) and hope this would help relieve that problem somewhat. I know there's been talks about finishing the Yazoo river levee and I support that as well. Needs to be done to protect our natural environment

These floods are awful for the wildlife in our area. The deer, rabbits, turkey and everything else suffer immensely during these events. This includes starving, getting hit by cars and an increase in disease pressure due to being clumped together so tightly on high ground. The water also gets far too deep for waterfowl to enjoy. This project would let us control the water and be so beneficial for everyone involved not just us humans

That's really all I have to say. If this project doesn't happen the south delta will eventually be an unpopulated region except for seasonal migrant labor and people too poor to move. We will lose an area rich in culture if something doesn't change. Thank you for your time I hope you read this far

-Luke Richards

From:	James Smith
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Delta Backwater Pumps
Date:	Tuesday, August 27, 2024 5:44:28 PM

Please complete the pump system for the betterment of the residents, agriculture and wildlife of the Mississippi Delta Region.

From:	Jeannine B. Coker
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] FINISH THE PUMPS FOR YAZOO BACKWATER PROJECT
Date:	Tuesday, August 27, 2024 2:27:57 PM

This email in support of Option 2 for the Yazoo Backwater Project. My family and I lost 3 homes to the Backwater Flood at Eagle Lake. The pier is still damaged due to the money lost and we refuse to complete it until the pumps are in. We lost not only our homes, but trees were destroyed and continue to fall during storms due to the damage sustained. Not to mention the wildlife lost. Please finish the pumps!!

Sincerely,
Jeannine Coker

Jeannine B. Coker
VP, Executive Risk Administration
500 South Service Road East
Ruston, LA 71270
Office Phone #: 318-232-7417
Fax #: 318-232-7478
Mobile #: 318-245-5957
jcoker@origin.bank
www.origin.bank

From: sse.9@stormassessor.com
To: YazooBackwater MVK
Subject: [Non-DoD Source] Finish the pumps
Date: Monday, July 29, 2024 4:35:18 PM

Please finish the pumps. We are all exhausted at this point of the game. We have tramped from one end of the Delta to the other. We are fatigued with the continuing saga with no end in sight. We have endured a total change of life here at Eagle Lake, a health impact due to the sand bagging we did to try to save our homes. We are desperately hoping this is going to be the end that results in a solution for our place we call home. Ladora & Larry Eubanks. Permanent residents.

From:	mandy denley
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Fw: Support the Pumps
Date:	Tuesday, August 27, 2024 6:24:59 PM

Sent from Yahoo Mail for iPhone

Begin forwarded message:

On Tuesday, August 27, 2024, 11:28 AM, mandy denley <mandolynn1028@yahoo.com> wrote:

To whom it may concern:

As a former resident of Mississippi, I'm writing to support Option 2 with the completion of the pumps that were included in the original flood control plan from 1941. The early start date for initiating pumping offers the best scenario for local agriculture, wildlife and quality of life for delta residents. A flood control plan that was implemented to protect the state from river flooding should not endanger the state due to trapped water behind the incomplete structures. The 2019 prolonged flood and devastation to our state should not be allowed to happen again.

I was born and raised in Mississippi Delta and though not a resident of the MS delta now, have direct knowledge of the impact and damage our state suffered during the prolonged backwater flood of 2019. I have family that live in that area and watched the physical, mental and financial suffering that they endured because the pumps were not installed as designed. Please finish this project as designed. I support Option 2 as the best alternative for the MS delta and our entire states economy.

Thank you!

From: Lindsey McMahon
To: YazooBackwater MVK
Subject: [Non-DoD Source] I support alternative 2
Date: Tuesday, August 27, 2024 9:30:12 PM

I helped people and had family who were devastated by the 2019 flooding. I watched whole herds of deer starve and die and trees die.

It’s time to finish the project that was designed and build the pumps.

I support alternative 2

Lindsey Klaus
Warren County

From:	Ken Klaus
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Klaus Comment
Date:	Tuesday, August 27, 2024 12:14:47 AM

I've spoken at every meeting. This is my last opportunity to comment, no holding back.

You know who we are; you've heard our stories. We're up to the 4th generation who have waited with hopes for a pump station since Congress abandoned the Eudora and Boeuf flood ways. The floodways would have reduced stages at Vicksburg during floods by 6 feet which means the 2019 Backwater Flood and others would have had little impact. The property owners in Arkansas and Louisiana would have been paid for flowage easements. The need for a pump station was obvious in the 1940's and is now. We have suffered financially, physically, and emotionally while Arkansas and Louisiana have benefitted.

The project has been studied numerous times with each of the prior reports resulting with a pump station being the preferred alternative. The pump turn-on elevation has risen from 80, to 87, to 90 or 93 with each requiring larger pumping capacity. Higher costs and a tougher sell to Congress.

While the wildlife, forests, property owners, and inhabitants have suffered, your report increases costs by claiming that the pump options will require mitigation for fish – when the backwater area exceeds the combined acreage of Mississippi's 5 largest reservoirs, mitigation for duck usage – when the report acknowledges that dabbler ducks only feed in water 2 feet deep or less, mitigation for wetlands – when prolonged flooding during 2019 killed a large percentage of the hardwoods in the wetlands of the lower areas of the basin, killed 70% of the wildlife with almost no birds nesting.

After the devastation of the 2019 Flood, all credible foresters, wildlife biologists, ornithologists, and economists support a pump station. A no-pump decision can only be based on greed – political payments from the elite whose goal is to force the reforestation of 200,000 acres of the most productive farmland. This during a time of worldwide food insecurity. These same elitists have corrupted the Sierra Club and the Audubon Society into opposing a project that actually supports their mission statements. Research NCX, the Bill Gates backed carbon credit company that seeded the carbon market with one-year contracts in 2022.

After the demonstrated devastation to the flora and fauna during the 2019 Flood, a no-pump decision will totally discredit the EPA. It will fully reveal that EPA has been bought and the pump issue is politically corrupt instead of based on science. It will result in a lawsuit of damages. The damages will be what we have endured compared to the benefits that Arkansas and Louisiana have enjoyed. Each team member producing this report should be deposed to explain how they chose a no-pump alternative when a fourth grader can explain what happened if they put a potted plant and a hamster in a bathtub full of water.

Each of your team's members knows the right decision. You must look into the mirror of your personal integrity; who will you see? Or have you been bought like the Sierra Club and Audubon?

I truly hope that my negative comments were misguided. If so, my appologies.

I join the vast majority of the South Delta in supporting Alternative 2.

Ken Klaus
Eagle Lake, MS
Ken.klaus88@gmail.com

Sent from Mail for Windows

From: Jim Bailey
To: YazooBackwater MVK
Subject: [Non-DoD Source] Option 2
Date: Tuesday, August 27, 2024 9:44:08 AM

Option 2 is the only workable, moral and fair option for everyone.
I have lived in this area for many years. First on hwy 465 where my family suffered five floods from the Mississippi and Yazoo rivers. These were short and workable. Then the federal flood control came. It came with many of the other options mentioned now. They talked about buying us out but never did. They used the 50% rule to force us out. I was left with a 40,000 mortgage that I paid off with my last flood insurance check. Between the government and the (county which devalued my home) from 70,000 to 40,000 I was left with nothing. Just a loan to start over.

What we are looking at now with backwater flooding is whole different animal. I built at Eagle Lake on high ground so as to never to see another flood but here we are. Now they are raising the flood level to build. Now I am a few inches out of compliance. Here comes the 50% rule and talk of buyouts and relocating families. If backwater flooding is fixable with option 2, then no more discussion is needed. It is time to protect families, wildlife and property.

James Bailey
Eagle Lake community, Vicksburg, MS

From: Janice Carriere
To: YazooBackwater MVK
Subject: [Non-DoD Source] Option 2
Date: Tuesday, August 27, 2024 7:02:19 PM

I was born and raised in Mississippi and though not a resident of the MS delta, have direct knowledge of the impact and damage our state suffered during the prolonged backwater flood of 2019. I have friends that live in that area and watched the physical, mental and financial suffering that they endured because the pumps were not installed as designed. Please finish this project as designed. I support Option 2 as the best alternative for the MS delta and our entire states economy.

Sent from my iPhone

From:	Jane Culbertson
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Pumps
Date:	Friday, July 5, 2024 8:18:58 PM

I have lived in Eagle Lake, Mississippi now for 15 years. In those 15 years, I have had to leave my house 3 times. Out of the 3 times, twice I've had to pack my belongings. My husband's job is at Eagle Lake. He doesn't get paid if he doesn't work which in turn, our bills don't get paid. I now work at Eagle Lake, as we both work for Tara Wildlife. This effects people's lives and jobs. People can't get medical attention, get medicine, buy food, get to church when they are surrounded by water every way they turn. We have fought for years over the pumps and struggled with leadership that don't give a damn about us. We count... help us get this done.
It's time.... Finish the Pumps.

From:	Jeff Terry
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Pumps
Date:	Wednesday, July 3, 2024 11:45:46 AM

It is time to finish this project, the South Delta cannot take another flood like we had in 19… please, the animals or people cannot survive with another 9 month flood, I live here, work here and my family has been here since 1947…
Thanks
Jeff Terry
601-334-0690
Sent from my iPhone

From: Lu Coker
To: YazooBackwater MVK
Subject: [Non-DoD Source] Pumps
Date: Wednesday, July 3, 2024 9:52:22 AM

Please help us with the flooding issue. We have a home at 319 Sea Island Drive and can’t afford to lose our home again due to flooding.
Thank you
Lu and Kathy Coker
Sent from my iPhone

From: Josh Miller
To: YazooBackwater MVK
Subject: [Non-DoD Source] Pumps
Date: Wednesday, July 3, 2024 10:58:54 AM

To Whom it May Concern,

I am writing in favor for the pumps. As a farmer and landowner near Onward, it will be of great help to those in the Backwater area. To many times floods have devastated wildlife, farms, and homes, and could've been prevented. Floods do not discriminate by race, religion, or gender. How many times over the last 75 years could the residents of the area been helped? Please put my comment down as a definitive "Yes".

Sincerely,
Josh Miller
Sharkey County
Sent from my iPhone

From:	Lindsey McMahon
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Support Alternative 2
Date:	Tuesday, August 27, 2024 9:35:36 PM

I support Alternative 2

Lindsey Klaus
Warren County

Ps i sent an email earlier and have no record of it. Hope this helps

From:	Kyle Klaus
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Support for Alternative 2 Yazoo Backwater Pumps
Date:	Tuesday, August 27, 2024 6:45:15 PM

I am sending this email to voice my support of Alternative 2 and the installation of the Yazoo Backwater Pumps.

I have hunted and enjoyed the resource that is the South Delta my entire life. It is of upmost importance for us to acknowledge the devastation that was the 2019 backwater flood and its impact on infrastructure and most importantly our wildlife and hardwoods. This area is where I spent my childhood hunting and fishing with my family. It is easily seen the impact this flood had on our wildlife and long standing hardwood forests. I know of trees that are older than anyone alive that are now dead, weakened, and blown over. Deer and bird populations are still recovering today. It should be an easy decision to install any mitigation effort to protect this region, not just for me but for my children.

Honestly not much is available in Mississippi as far as healthy activities aside from our great outdoors. This is in threat of being lost. Knowing that these types of pump stations are successfully in place elsewhere and are in threat of being denied in my area is a slap in the face. I have not heard any common sense reason to not install them, and I have heard all reasoning. Anyone not living in this region should not have a say in how we protect our resources. Anyone in favor of maintaining natural habitat and wildlife should be in favor of these pumps, it is plainly seen in our hardwood forests what inundation effects can have.

Please for the sake of my children’s future in the outdoors of my home region of Mississippi, build the pumps.

Thank you,
Kyle Klaus

From: jackie henne kerr
To: YazooBackwater MVK
Subject: [Non-DoD Source] Support for Yazoo Backwater Pump Option 2
Date: Monday, August 12, 2024 6:35:42 PM

To whom it may concern:

Please note this is documentation to justify a pump and option #2 as the best alternative for the wetlands and their associated plant communities. However, I am afraid that with the elevations noted and start date of the pumps in this option, we will still have degradation of the wetlands especially in Delta National Forest and other hardwood bottoms of the same elevation.

- It seEms that the general consensus is that the pump will be bad for the wetlands in the South Delta and mitigation is needed if the pump is put in place. This is just not true. The pump will help the wetlands be healthier because the excess water will be removed and the normal drawdown of the water levels can occur.
- This project includes adding low flow wells in the north part of the Delta which is benefitting the aquatic ecosystems throughout the Delta – Why do we have to mitigate for this good feature of the project?
- Working on Delta National Forest in 1990, I thought the bottomland forest was so beautiful. I was told by other professionals (wildlife and forestry) as well as "old timers" that grew up and hunted here "you should have seen it in the '50s and '60s." And as I look at it now in the 2020's I think how poor it looks compared to the 1990's. It is obvious to a trained eye that this backwater flooding is degrading the forest ecosystems here in the South Delta.
- In 1990 I was told that the "flooding" was causing forest species composition shifts and reduced species diversity by a forester on Delta National Forest. As I watched the water levels in these different ecosystems in the South Delta over the past 30 years, I can see why. The water is not receding or drying up during the growing season thus causing individual species (like the pond berry) and whole communities to die out. How can anyone say this water is good for the wetlands.
- If I have heard it once, I have heard 1000 times "the plant communities in the South Delta evolved with flooding; they will be fine" NO, NO, NO, NO!!!! The South Delta did evolve with flooding – WINTER FLOODING! And with winter flooding, I agree they would be fine. BUT this is not winter flooding, it is flooding during the growing season and they will not be fine with summer flooding.
- When talking about this situation folks talk about the growing season and mean the farm crop growing season. ALL PLANTS HAVE A GROWING SEASON, this man-made flooding is preventing the bottomland ecosystems to thrive because they are flooded during their growing season.
- When I try to explain the situation of too much water over these hardwoods I use a beaver dam as an example. I am not saying beaver dams are bad, but it can be used as an example to understand this. When beavers dam up a drain, it causes water to stand over the trees throughout the year. After several years the hardwood trees standing in

that water die. The beaver did not kill those trees directly by chewing on them or cutting them down. They died because their roots were underwater too long. Roots of hardwood trees need to be aeriated during their growing season. Some will hang on longer than others especially if they are on higher ridges and around the edge of the beaver dam where they might dry out some each year, but they will be unhealthy. This is a perfect example of what is happening to the hardwood trees here in the South Delta due to the backwater flooding.

- Pondberry colony numbers are down from those observed and followed from the 1990's to the 2020's, by close to 70%. Why, flooding during the growing season. They can not leaf out and recharge stores in their roots to flush the next year if they are under water for the majority of the growing season.

- Recent research from Stoneville showed that pondberry can tolerate flooding for 90 days – in Jan to April. They did not evaluate colonies flooded 90 days in June through August. I think we know why, that is not when they were normally flooded.

- Research was done in 2008-11 (I think) to evaluate if the pumps would or would not hurt the pondberry. The study found that the pumps would not hurt the pondberry. Unfortunately, this study did not have the option to say the pumps would help the pondberry. I think we see now if that was an option, the study would have concluded that the pumps would help the pondberry.

- There is concern that water released from the South Delta area will add to the overload of fresh water flowing into the gulf which caused major problems to the saltwater ecosystems several years back. I'm wondering if the pump is put in place and the water would be released from the Delta area earlier than the majority of fresh water from farther north, would this actually do less damage than without the pumps.

- There was extensive sediment movement into drains and wetlands from the farm fields due to the high water in 2019 and 2020. The wave action of the water setting on the fields throughout the summer moved soil as evident to deposits on roads which had water splashing onto them during heavy winds.

- I understand some people feel that the South Delta should be put back into trees and then a pump would not be necessary. Of course, this option does not take into consideration generations of families that have lived and want to live here. But also, it doesn't consider that trees cannot tolerate the back-water flooding any better than the farm crops.

- This is a man-made problem and has a proven man-made solution. The success of the pump is not speculation. There are other projects just like this one in similar situations and they have residents, farmland and functional healthy wetlands within their levee systems.

- I've heard people say let the science dictate what needs to be done. Representative Bennie Thompson even put this in a letter to the EPA. I agree, but the science has to be from here in the South Delta. And we have the science from here that proves the pump is necessary for the wetland ecosystems present.

- I am concerned that Audubon says that installing the pump will destroy 200,000 thousand wetlands which support 250 bird species and they specifically mention waterfowl. I can't find the 200,000 acres that will be destroyed. As for the waterfowl, from what I experienced, the high water in 2019 and 2020 negatively affected waterfowl because it prevented vegetation growth that provide food for the wintering waterfowl. The pump could have reduced the flooding, allowing for wintering waterfowl foods to grow.

- I hate that the USFS and the NRCS as other agencies that are aware of the devastation caused to the environment due to the lack of pumps can not weigh in with their knowledge because they are not allowed to because it is a political issue.

As I see it putting the pumps in and removing backwater flooding as early as possible is a win, win, win, win… situation. Who will win? In the South Delta the breeding and wintering birds, resident mammals, reptiles, amphibians, fish, butterflies and other insects, plants and the whole bottomland forest ecosystem, Delta National Forest (which by the way is the only 100% bottomland forest the USFS has,) the endangered pondberry, farmers, residents you name it will benefit. Even the wetland ecosystems in the North Delta will benefit from the low flow wells.

I don't mean to sound condescending; but, if anyone opposes the pumps and the earliest possible turn-on date they are just not familiar with what is happening here. Their opposition is hurting the very thing they say they want to protect. I came from North Dakota and before I lived and worked here as a biologist and forest manager, I might have felt the same way. But trying to manage land and seeing the devastation due to the lack of the pump, I just want to scream and cry at the loss of habitat and wildlife here in the South Delta.

Please confirm option 2 as the only viable option for the Yazoo Backwater flooding issue.

Jackie Kerr

1-662-820-4783 please leave message and I will return your call.

From:	Leslie Holloway
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Twin County EPA Backwater Project Letter of Support
Date:	Tuesday, August 27, 2024 5:24:47 PM
Attachments:	Twin County EPA Yazoo Backwater Letter of Support.pdf

Please find a letter of support on behalf of Twin County Electric Power Association.

Any further documentation or questions can be directed to me.

Thank you,
Leslie Holloway
General Manager

Leslie Holloway
General Manager
Twin County Electric Power Association
PO Box 158
Hollandale, MS 38748-0158
Cell: 870-245-8492
Office: 662-827-2262

TWIN COUNTY
Electric Power Association
HOLLANDALE, MISSISSIPPI 38748-0158
P.O. BOX 158
TELEPHONE: (662) 827-2262
FAX: (662) 827-2832
BRANCH OFFICES
BELZONI, ROLLING FORK AND GREENVILLE

August 27, 2024

Attention: CEMVK-PPMD
Vicksburg District, U.S. Army Corps of Engineers
4155 East Clay Street
Vicksburg, Mississippi, 39183

Re: Letter of Support-Yazoo Backwater Project

To Interested Parties:

Twin County Electric Power Association (TCEPA) is a non-profit electric distribution cooperative headquartered in Hollandale, Mississippi, with district offices in Greenville, Belzoni, and Rolling Fork, Mississippi. TCEPA provides electric utility service to approximately 6,800 member-owners and 13,000 meters in Washington, Humphreys, Sunflower, Issaquena, and Sharkey County, MS. The 2019 Mississippi River flood was historic for its duration and record-setting water levels in the Yazoo Backwater Area. The flood caused significant economic damage to TCEPA and the communities it serves. TCEPA incurred $1.7 Million in expenses for infrastructure replacement, power restoration and loss of margins. Many residential customers were displaced from their homes, agricultural production was disrupted, and recreational businesses suffered due to habitat being forced from the area. In November 2019, TCEPA's Board of Directors adopted a resolution supporting the installation of the Yazoo Backwater Project Pumps. I am attaching a copy of the Resolution as an addendum to our letter of support.

TCEPA supports Measure 2 of the Yazoo Backwater Area Water Management Project Mitigation Plan to address future habitat impacts and ecological resources.

As a community stakeholder, TCEPA looks forward to continuing collaborative efforts to support the Yazoo Backwater Area Water Management Project Mitigation Plan.

Sincerely,

Leslie Holloway

Leslie Holloway
General Manager

CERTIFIED COPY OF RESOLUTION OF BOARD OF DIRECTORS OF TWIN COUNTY ELECTRIC POWER ASSOCIATION

WHEREAS, Twin County Electric Power Association ("**Twin County**" or the "**Association**") serves parts of Warren, Issaquena, and Sharkey Counties in Mississippi; and

WHEREAS, a significant number of Twin County's members were adversely effected by this year's backwater flood; and

WHEREAS, Twin County experienced a significant loss of revenue and incurred significant additional expenses as a result of this year's backwater flood; and

WHEREAS, The Flood Control Act of 1941 authorized the Yazoo Backwater Project to provide protection from higher stages on the Mississippi River resulting from the removal of the Eudora Floodway Project in Arkansas and Louisiana from the Mississippi River & Tributaries Project; and

WHEREAS, the Yazoo Backwater Project authorized drainage structures, levees, and pumps to move water out of the Mississippi Delta during a high water event on the Mississippi River; and

WHEREAS, the backwater areas in Arkansas and Louisiana have installed pumps; and

WHEREAS, the United States Environmental Protection Agency vetoed the installation of the Yazoo Backwater Project pumps in 2008; and

WHEREAS, the Yazoo Backwater Project pumps would have reduced the backwater flooding crest by over five and one-half feet, and would have reduced the area flooded by approximately 194,000 acres (including 122,000 acres of crop land), and would have prevented the flooding of homes and highways; and

WHEREAS, Twin County's Board of Directors believes that the installation of the Yazoo Backwater Project Pumps is in the best interests of Twin County and its members.

NOW, THEREFORE, BE IT RESOLVED that the Board of Directors of Twin County does hereby endorse the installation of the Yazoo Backwater Project Pumps as soon as possible, and encourages the United States Government to authorize and fund the installation of the Yazoo Backwater Project Pumps as soon as possible to prevent future flooding.

CERTIFICATE OF SECRETARY

I, **Billy George Janous**, the duly elected and acting Secretary of **Twin County Electric Power Association**, and the custodian of the minutes and other records of said Association, do hereby certify that the above and foregoing is a true and correct copy of the Resolution adopted by the Board of Directors on October 15, 2019, and that there has been no further action of the Board of Directors which would alter, amend or rescind the action taken herein.

DATED: November 19, 2019

TWIN COUNTY ELECTRIC POWER ASSN. MISS. CORP. SEAL

Billy George Janous

BILLY GEORGE JANOUS
Secretary-Treasurer

From:	Joyce Foshee
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Vicksburg resident
Date:	Wednesday, July 3, 2024 11:38:08 AM

Good Afternoon,
I hear that the CORE would like our comments again about the backwater flooding. Being only a resident of the South Delta since 2019, I can only voice my experiences of the last flood.
All the Eagle Lake residence were trying so hard to keep the water from coming over. We worked tirelessly sand bagging, pounding T post, strapping tin to them, helping people move their stuff to higher ground, trying to find alternate living arrangements. Then it still happened, 3 ft of water under our house, lost equipment, propane tank filled so no water.
We survived it, the wildlife didn't fare so well, if the deer didn't get hit but vehicles, they starved or drowned looking for somewhere to go.
Rerouting our commute over an hour detour and still had to be very careful, the levee was not built handle everyday traffic.
It is my hope and prayer that the 'FINISH THE PUMPS" can be finished and put this long awaited, waste of time, resources to bed. Probably more money spent fighting over the pumps than it would have cost to just do the job.
Thanks to the Vicksburg CORE for working with us.
Bobby and Joyce Foshee
119 Belle Island Dr
Vicksburg, MS 39183

From: John Watkins
To: YazooBackwater MVK
Subject: [Non-DoD Source] Yahoo Backwater Pump Project
Date: Tuesday, August 27, 2024 1:57:31 PM

To whom it may concern,

I grew up in Vicksburg, experienced the '73 flood as a young college kid, worked for the District in Hydraulics Branch and Regulatory Branch from '82-'96, was involved in every flood fight during that period of time. I've seen the damage, mayhem caused by these catastrophic events.
I fully support Alternative #2 and encourage USACE to implement.

Sincerely,
John C. Watkins

From: Lynn
To: YazooBackwater MVK
Subject: [Non-DoD Source] Yazoo Backwater Project (YBP)
Date: Thursday, July 4, 2024 7:53:07 AM

Hello,

My husband and myself are full time residents of Eagle Lake in northern Warren County, MS., we have lived here for 27 yrs and love were we live. We have been through flooding of our area numerous times, and a few times it was severe enough for residents to evacuate. One time we lived at a hotel in Vicksburg for an entire month until we could move back home to Eagle Lake, yes it is frustrating and stressful, some residents move away, but we continue to stay here cause we love where we live, we enjoy the wildlife also. We have also seen wildlife dying along the road and in residents yards from the severe flooding. Farmers cant work and lose money that is suppose to support their families. We have needed this pump for many, many, many years. There is no excuse as why we can not have the Yazoo Backwater Pumps. Mississippi is the only state along the river that DOESNT have any pumps !! Politics should not be an excuse either. The folks that continue to block the pumps would not appreciate it if their own families were subject to flood and need the pumps. People that continue to block the pumps are killing the wildlife and could drown residents in a flood, they are also taking money from farmers and their families if they cant farm. Mississippi is already a poverty state, why continue to enable that by letting residents get flooded out of their homes?

Please help your fellow man and install the PUMPS today !!!!!!!!!!!

From:	Cummins, Jason
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Yazoo Backwater Project
Date:	Wednesday, August 7, 2024 9:00:05 AM
Attachments:	image001.png

To whom it may concern:

My name is Jason Cummins, I am a lifelong resident of Warren county Mississippi and currently reside in the Eagle Lake community at 315 Shell Beach Road. I am employed at Lamb Weston in Delhi, Louisiana and consider myself an avid outdoors enthusiast.
I enjoy the natural beauty of the Yazoo Backwater Area and the life that it provides for my family. I've also experienced firsthand the devastation that the flooding events has caused for this area. Especially the 6-month flood of 2019.
The unknown of when it will occur again is frightening but even with that the joy the area brings to me, and my family outweighs the fear. Through the years, I've attended every meeting about flood control in this area and have more hope now than ever that we are finally making progress.
I fully support the Proposed Water Management Solution that includes the pumps with an operating scenario in Alternative 2.

Thank You!

Jason Cummins
Team Leader
Maintenance | Processing
Lamb Weston - Delhi
77 HWY 609. | Delhi, LA 71232

318-488-6149 | f: 318-878-6041 | c 601-618-7307
jason.cummins@lambweston.com

LambWeston
SEEING POSSIBILITIES IN POTATOES

From: Jason Barnes
To: YazooBackwater MVK
Subject: [Non-DoD Source] Yazoo Backwater Pump Project
Date: Tuesday, August 27, 2024 7:47:22 PM

I'm in support and encourage you to proceed with option 2:

Alt 2 - Construct a pump station with an earlier turn-on date

Jason Barnes

From: Linda
To: YazooBackwater MVK
Subject: [Non-DoD Source] Yazoo River pumps
Date: Wednesday, July 3, 2024 10:05:02 AM

How much study is still needed???
Studies have shown that this current plan will work
Too many lives, livelihoods , wildlife etc have been affected by these floods
Let's get the pumps approved and safe a beautiful area

S A Sikes
Linda E Sikes
17765 Hwy 465
Vicksburg MS 39183

From:	Brenda LAVIGNE
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Flooding
Date:	Friday, June 28, 2024 12:41:17 PM

We are the only area that flood control was not used from years ago, since we were left out, catastrophic flooding has occurred. Not only towns and communities were damaged, but the wildlife was destroyed by drowning, lack of food, they were horribly starved. The natural flora and fauna was also destroyed, where some will probably never come back, farmland was damaged, trees were actually drowned, where their root system can't get air to survive and died! Please put them in . Every living thing has been severely affected and compromised by the tragic floods due to lack of the flood control by the Army Corp of Engineers.

Brenda Lavigne 3610 Eagle Lakeshore Road, Vicksburg, MS
601-818-5150
Sent from my iPad

From:	Betsy Scott
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Option 2
Date:	Tuesday, August 27, 2024 4:32:01 PM

This is my second email in support of Option 2 from the options provided to us by the EPA and the USACE, my first was in July. I hope my two emails carry more weight than the approximate 100,000 form letter emails vomited out by the lemmings following each other over the cliff driven by environmental groups with no factual information or knowledge about what they are responding to.
I hope engineering and science carry more weight than emotions and volume of emails. I hope the studies done by MSU, MEMA, MSEMA, the EPA, the USACE and other agencies have proven that the flood project should be completed and the pumps should be installed. I hope that the USACE will have more flexibility in the operation of water levels and activation times based on current situations, weather and climate conditions and environmental impact rather than hard dates or levels.

I continue to support Option 2,

Betsy Bailey
840 Eagle Lake Shore Rd
Vicksburg, MS

From: Betsy Scott
To: YazooBackwater MVK
Subject: [Non-DoD Source] Option 2
Date: Tuesday, August 27, 2024 3:53:14 PM

It's 2024 and I can still see the damage incurred driving to and from my home at Eagle Lake from the prolonged flooding that occurred in 2019. More and more hardwood trees fall across highway 465 with each light storm. By my amateur count of animals that I see on my route, the wildlife have not fully returned to the area. I still see empty homes and multiple broken piers and docks on the lake from people too mentally or financially exhausted to rebuild. Multiple cypress trees in the middle of the lake that provided animal habitat and shade for boaters are dead from being underwater for so long. Our highway and county roads still bear scars with sunken areas, narrow dangerous shoulders, pot holes and poor striping. We are the only state with a flood project like this that is left uncompleted. We need an overflow system or drain for this giant bathtub that was created, we need the pumps installed and the project completed.

I appreciate the joint work of the EPA and the USACE and hope that installation of the pumps will begin as soon as possible. I support Option 2 as the best solution based on the four options provided. Whether these dates and levels are the best is still debatable. I believe that the USACE should have more flexibility in managing activation times and water levels based on situation, science and expertise.

From: cliff kirby
To: YazooBackwater MVK
Subject: [Non-DoD Source] Pumps
Date: Wednesday, July 3, 2024 9:46:42 AM

With everything we went through in 2019 that should be enough for the government to step in and help.With the crops the the houses lost.We know there is a solution to the problem. Please finish the pumps
Sent from my iPhone

From: Brad Britton
To: YazooBackwater MVK
Subject: [Non-DoD Source] Pumps
Date: Thursday, July 25, 2024 11:18:01 AM

Good morning. My husband and I support Initiative 2 for finishing the pumps. We own Britton Furniture in Rolling Fork and the flood devastated our business for two years. I would stay at the store and hope customers would come in while my husband would go help sandbag in our area. Please help us save the Delta by finishing the pumps. We just went through a devastating EF4 tornado that destroyed our business. We have built back and are here to serve the Delta area for years to come. Please put the pumps in so we don't have to worry about flood waters ever again.

Sincerely,
Brad and Jennifer Britton
Britton Furniture, owners
662-822-4244

From:	Caitlin Scott
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Pumps
Date:	Tuesday, August 27, 2024 6:58:53 PM

Yazoo Backwater project As a resident of Mississippi I'm writing to support Option 2 with the completion of the pumps that were included in the original flood control plan from 1941. The early start date for initiating pumping offers the best scenario for local agriculture, wildlife and quality of life for delta residents. A flood control plan that was implemented to protect the state from river flooding should not endanger the state due to trapped water behind the incomplete structures. The 2019 prolonged flood and devastation to our state should not be allowed to happen again. I was born and raised in Mississippi and though not a resident of the MS delta, have direct knowledge of the impact and damage our state suffered during the prolonged backwater flood of 2019. I have friends that live in that area and watched the physical, mental and financial suffering that they endured because the pumps were not installed as designed. Please finish this project as designed. I support Option 2 as the best alternative for the MS delta and our entire states economy. As a Mississippi resident I do not understand why flood control projects were completed in every other state but ours. Those states did not suffer the devastation that occurred here in 2019 or threatened in 2020. The installation of pumps and earliest starting date for pumping are imperative for the survival of the Mississippi Delta. Option 2 is the best solution to protect the MS Delta's infrastructure, wildlife, agriculture, work force, access for emergency services, medical care and quality of life for residents - and to insure that this prolonged man made tragedy does not occur again. A giant bathtub was created in the Mississippi Delta with the implementation of the 1941 flood management plan without the completion of an emergency overflow. I'm glad to see that the EPA and the USACE are working together to remedy and prevent future backwater flooding. Option 1, doing nothing, and buy outs are not the answer. The answer is finish the pumps! Option 2 in my opinion provides the best timeline for farmers and residents to negate the impact of spring flooding and prevent the 6 months of devastating flooding of 2019 from happening again. My family suffered physically, emotionally and financially from the prolonged flooding that occurred due to the lack of pumps and incompletion of the Yazoo Backwater Project. I'm writing to support Option 2 as the best solution provided by the EPA and USACE in preventing this disaster from happening again. The devastation from backwater flooding in 2019 should not have occurred and should be prevented from happening again. The damage to the environment, wildlife and infrastructure can still be seen today. My family suffered physically, emotionally and financially from the prolonged flooding that occurred due to the lack of pumps and incompletion of the Yazoo Backwater Project. I support Option 2 as the best solution provided by the EPA and USACE to save the Mississippi Delta and our states economy.

Caitlin Scott

From:	Chase Koestler
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Re: Pumps
Date:	Tuesday, July 23, 2024 10:18:24 PM

Kindest Regards,

Chase Koestler
Land Professional

430 Hwy 49 South | Jackson, MS 39218

Office: 601.878.2484 | **Mobile:** 601.529.0512

NationalLand.com | **My Listings**

On Tue, Jul 23, 2024 at 9:57 PM Chase Koestler <ckoestler@nationalland.com> wrote:

> Good evening I attended todays mid day meeting in Vicksburg. I listened to the comments from farmers and residents that dealt with the flooding in years past. I have grown up in Vicksburg and spent countless hours in the Eagle Lake and Mississippi Delta throughout my 40 years of life. It is sad to see what is still ongoing with this project or should I say lack of. I hunted along the Mississippi River just north of Eagle Lake for most of life, the flooding of the ms river in recent years has changed the landscape of the the delta. The bottomland that was once oaks, pecans, cottonwood, sycamores, ash, and persimmons is becoming predominantly a Willow thicket with what is left of the hardwoods decaying by the minute. I have managed hunting properties for the last 15 years in Ms, La, and Ark I see what goes on daily with wildlife and habitat in these areas. The amount of habitat that once flourished when I was a kid now looks very depressing to say the least. The invasive grasses and trees are beginning to take over the lower elevation areas that were once big beautiful pecan flats with occasional oaks(24-32 ft elevation areas along the river), the areas that were mid 30s to upper 30s have see deteriorating habitat as well along the river. The backwater side of the levee is detrimental for wildlife to survive, and during the high water events we have to find a way to keep it dry. I understand the concerns with wetlands but it's obvious the flooding is destroying hundreds of thousands of acres of forest and turning into wetlands due to flooding. Trees cannot withstand the prolonged flooding in the spring and summer. The dewberries that once thrived have become invasive sedge flats in areas, hardwoods have been replaced with wetlands habitat or ash flats. I know from managing 15k plus acres for the last fifteen years you cannot afford to fix the river now that it's where it is!! It's unbelievable the changes I have seen in my short time on this earth. This project is way overdue let's make a difference and put these pumps in. If you want to mitigate by taking some of the lower elevation areas and putting them into forest or Wrp I would support that

but you still need a place for wildlife to go in the high water. I am no scientist, biologist, or engineer but I have lived in the woods for the majority of my life; I have seen the decline in habitat from these floods. These animals are just like people they wait until last minute to leave, but then come back as soon as water starts falling. It’s vital we do everything we can to improve the habitat for wildlife on the protective side of the levee. The fishing has absolutely declined in these areas due to sediment and the changing landscape. There has been nothing good come out of the flooding! There are so many on going issues facing us today let’s not let this one keep continuing to hold the people and towns of the south delta down. Businesses depend on the recreation, farming, and tourism in the south delta!! I support alternative 2 if I had to pick but I honestly think we can do better for the communities and the wildlife. Thanks for working on this project and I pray that something happens in the near future because future generations depend on it. I have a hands on understanding of this area, wildlife, and habitat would be glad to help anyway that I can.
Kindest Regards,

Chase Koestler
Land Professional

430 Hwy 49 South | Jackson, MS 39218

Office: 601.878.2484 | **Mobile:** 601.529.0512

NationalLand.com | **My Listings**

From:	Cheyne Robinson
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Support option 2
Date:	Tuesday, August 27, 2024 10:39:07 AM

I have owned land in the backwater area for most of my life. My family has been here for over 80 years.
Currently I live at Eagke Lake. I run one buisness from there as well operate another in valley park. In the last 10 years the losses I have encountered have been devastating to my family, both emotionally and financially.
First It depleted our savings and now the loans, along with the extreme inflation, are driving me further in debt. This man made problem has changed my life as well as my children's. We struggle to pay for higher education that would have been taken care of with savings exhausted.
Simply put I have nowhere to go an our livelihood depends on your decisions.
Thank you for considering our support!
Sent from my iPhone

From:	Carol Ann Murphy
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Yahoo Backwater
Date:	Wednesday, August 21, 2024 9:51:54 AM

Dear USACE, EPA, and NWFP

Thank you for your continued support on addressing the Yazoo backwater area pumping station. It did not take me long to know that alternative too is the best option we were given to choose from we live in the Eagle Lake community since 1942. We have confidently invested our lives into our home and properties, we knew Congress authorize the MRNT Levi with pumping stations in the 1941 congressional order we built our to code and steal it floods our property for months in 2000 1980 years ago. It was authorized is not finished until the last pump is built, may is the 93 level when the pumps would turn on we are at the bottom of the bathtub. We're hundred of thousands of water drains here making the rain water raspberry fast , the pumps need to turn on before the 93 foot elevation to ensure Eagle Lake will not flood further destroying our property on the Lakeside and our peers. We were confident our government we complete the project yet here we are 80 years later and we have seen continued flooding. I'm majority of the last few years , we are homeowners and we have lost $250,000 worth of our property in the last flood. The farmers have it worse and the wildlife and trees are dying. People are dying if the water is managed per alternative too that was certainly help if you were able to adjust the water level and dates as needed to protect the Yazoo backwater area , because we can never predict whether events that would be best for all the main alternative to with the option to adjust when the pumps are turned on and went to lower the water rainwater levels. This will be proactive measure to prevent damaged our communities and structure wildlife and our farmers to plant , when Louisiana has to optimize their crops this is why the USA started an injustice stagnant mass over septic systems degrading the environment, and causing health issues and un-American is an American is human and environmental and justice sincerely Carol Ann Murphy 295 Shell Beach Rd.

Sent from my iPhone

From:	Chad Ladner
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Yazoo Backwater Project Public Comments - ATTN Mike Renaker
Date:	Friday, July 12, 2024 12:14:06 PM
Attachments:	Yazoo Backwater Project Comments Chad.pdf

ATTN - CEMVK-PPMD / Mike Renacker,

I'm a landowner in the Yazoo Backwater Study Area and enthusiast for the >200,000 acres of public lands listed in the area. I've enjoyed hunting, fishing, and other activities on these areas and the waterways with the Yazoo Basin for 20+ years and sustainability of these resources is very important to me, my family, and many friends. Over the years we have seen firsthand declines in many aspects, and it is very concerning to us. This project has the potential to reverse those trends, so we are very interested and excited about how it could impact the area in a positive manner.

Please see attached for comments and questions for consideration when finalizing the proposal that is summarized in the draft EIS report and associated appendices posted on June 2024 for public comment.

Thanks,
Chad

ATTN – CEMVK-PPMD / Mike Renacker,

I'm a landowner in the Yazoo Backwater Study Area and enthusiast for the >200,000 acres of public lands listed in Table 4-8 of the EIS report. I've enjoyed hunting, fishing, and other activities on these areas and the waterways within the Yazoo Basin for 20+ years and sustainability of these resources is very important to me, my family, and many friends. Over the years we have seen firsthand declines in many aspects, and it is very concerning to us. This project has the potential to reverse those trends, so we are very interested and excited about how it could impact the area in a positive manner.

See below for comments and questions for consideration when finalizing the proposal that is summarized in the draft EIS report and associated appendices posted on June 2024 for public comment.

Thanks,

Chad

1. On page 10 of the main EIS report, it is mentioned that four green tree reservoirs (GTRs) were completed by the MVK in the Delta National Forest in the late 1970s and early 1980s to mitigate fish and wildlife losses resulting from flood control works that were part of the earlier stages of the Yazoo Backwater Project. It also states that the GTRs and the slough control structures are not being operated by the U.S. Forest Service (USFS), nor are they being maintained by the MVK. This differs from the Yazoo Backwater Area Reformulation report that was published in October 2007 in where it is stated on page 7 of that report that the existing (4) GTRs were being operated by the USDA Forest Service and maintained by MVK. What has changed between now and 2007? Are the GTRs and slough control structures being operated and maintained by another party? If yes, can you please include those details in the report since they pertain to the sustainability of mitigation for past MVK actions associated the overarching Yazoo Backwater Project? If the claim is that the GTRs are still providing mitigation as originally planned in 1976, please provide additional details on how the (4) existing GTRs were operated over the past 10 years including the flood schedules and at what pool levels they were flooded to ensure an adequate wetland function and habitat for wildlife including waterfowl. If the GTRs are no longer in operation or maintained as originally planned in 1976, allowing prior Yazoo Backwater Project mitigation efforts to expire or cease operations without additional offsets doesn't seem like a sustainable plan, and it doesn't seem like it's in the best interest of the wildlife or for future generations to enjoy the benefits provided for public use. It would also contradict how the backwater levee system is operated and maintained (see section 1.2 on page 4 where it is stated that operation and maintenance of the levees are the responsibility of the Federal government). If this is the case, backlogged mitigation requirements for already constructed portions of the overarching Yazoo Backwater project should be accounted for in the current mitigation proposal and water management plan associated with this phase of the project, which is contrary to what is stated in the second paragraph on page 12 of the main EIS report.

2. On page 24 of the main EIS report, there is mention of modeling data showing that a 25,000 cfs pump would have taken 8 days to draw the water down from 98 feet to 97 feet during the 2019

flood. It is then stated that the calculation can be extrapolated to indicate that it would take up to 24 days to draw the water down from 93 feet to 90 feet (8 days per foot multiplied by 3 feet). That math appears to be too simplistic and short sighted ignoring the fact that the surface area and volume of water in the Yazoo Backwater Area would be different at 98 feet versus 93 feet. MVK should consider developing an expected draw down period that is supported by modeling data relevant to 93 feet to accurately calculate the duration of pumping required to reduce the level to 90 feet which would provide a stronger technical rationale to support the dates chosen for the crop and non-crop season dates in Alternative 2.

3. Context should be added to sections 3.3.2.1 and 3.3.2.2 on pages 32 thru 35 of the main EIS report to explain the functionality of the pumps during a Project Design Flood event where the backwater levee systems are overtopped by design (as explained on page 84 of the main EIS report). It seems like the pumps would provide additional flexibility to get floodwater off lands above the 5-year floodplain in an expedited manner rather than being at the mercy of the Mississippi River and relying on it to drop >14 feet post crest before floodwaters could recede below the 5-year floodplain via the Steele Bayou WCS. While an event like this has not occurred to date, it should be considered when weighing the benefits of each alternative since there was a near miss during the May 2011 Mississippi River flood event where the riverside gage at the Steele Bayou WCS reached 106.2 feet and was just a few inches from overtopping the backwater levee system (as explained on page 86 of the main EIS report).

4. In section 3.6.9 on page 45 of the main EIS report, would the maintenance plan for the low flow wells be susceptible to MVK budget cuts? If so, acknowledging that functionality, mitigation efforts, and potential additional environmental impacts would be exposed to federal budget cuts in the future should be considered in this section.

5. On page 106 of the main EIS report, the intro statement for the “Alternatives 2 and 3” section is attempting to explain the differences between the two alternatives but is not accurate. The intro statement should be corrected to point to the differences between the two alternatives (season dates only).

6. In section 5.1.3 on page 112 of the main EIS report, there should be consideration for adding a cross reference to section 4.2.1.3 under the No Action Alternative. As-is, it can be read out of context that no impacts to farmland would occur. Having this section point back to the Farmland Protection Policy Act should provide clarity on what is being stated.

7. On page 121 of the main EIS report, under the No Action Alternative it is stated that project related impacts to recreational resources would not be expected. This conflicts with some of the things that are stated on section 4.2.1.5. In Table 4-8, Howard Miller WMA and Mahannah WMA are listed as susceptible to backwater flooding but also as managed for waterfowl. Waterfowl management on the South Delta WMAs typically involves the planting of crops or moist soil management and both hinge on the ability to control water levels within the managed impoundments during certain times of the year. You should consult with MDWFP’s waterfowl biologists to ensure they agree that future waterfowl management practices would not be

exposed to potential interruption with Alternative 1 or Alternative 4, as they were during the spring and summer months of 2019 and 2020. Conversely, I would expect the nonstructural features of Alternatives 2 and 3 to have a positive impact on the waterfowl management practices at Howard Miller WMA and Mahannah WMA as MDWFP would then have full control of water levels on the managed units above the 5-year floodplain throughout the year and especially during the growing season for crops and moist soil plants within the 2-year floodplain.

8. In section 5.2.4 on page 142 of the main EIS report, it is stated that there would be no direct impact to wildlife for Alternative 1. This is another instance that may require additional coordination with MDWFP biologists to ensure impacts from unimpeded backwater flooding above the 5-year floodplain are captured correctly within the EIS report. For example, it is a known fact publicized by MDWFP that the turkey population in the Yazoo Backwater Area was severely impacted by the flooding events over the past 10 years. As a result, turkey hunting has been closed by the MDWFP at most of the WMAs listed in Table 4-8 since 2016 to counteract the impact of the uncontrolled long duration flood events in the Yazoo Backwater Area.

9. In section 5.2.5 on page 143 of the main EIS report, it should say the YSA currently provides an average of 6,571,178 DUD instead of 202,798 under the No Action Alternative to align with what is stated on page II of Appendix F-5. There is also a difference in how the No Action alternative is referenced in the main report versus Appendix F-5. The main report labels the No Action alternative as “Alternative 1” whereas Appendix F-5 does not label the No Action alternative but does label “Alternative 3” from the main report as “Action Alt 1”. These labeling differences should be cleaned up in the final report to aid readers with cross referencing between the main report and Appendix F-5.

10. In section 5.2.5 of the main EIS report, consider adding statements under Alternative 2 and Alternative 3 that the pump will provide opportunities for adaptive management to consider modifications to the Yazoo Backwater Area’s water management plan such as the non-crop season inflow gate closure threshold for the Steele Bayou WCS which could have a positive impact on DUD during the winter waterfowl migration season and help provide a long term path for meeting the Lower Mississippi Valley Joint Venture population and habitat objectives detailed on page 4 of Appendix F-4. Think of the Yazoo Backwater Area’s 2-year and 5-year floodplains functioning as a large impoundment or GTR with more reliance on inflow from the MS River in lieu of local rainfall when deriving this statement and considering action.

11. In sections 5.2.7 and 5.2.8 of the main EIS report, consider adding statements under Alternative 2 and Alternative 3 that the pump will provide opportunities for adaptive management to consider modifications to the Yazoo Backwater Area’s water management plan such as the non-crop season inflow gate closure threshold for the Steele Bayou WCS which could increase connectivity with the Yazoo and Mississippi River systems and provide additional benefits to the aquatic resources, fisheries, and water quality. Having increased connectivity between the floodplain and the Mississippi River should also benefit the wildlife and fisheries as well as the threatened and endangered species described in section 4.2.2.6.

12. Appendix F-4 and Appendix J have conflicting land coverage areas listed for the 90 ft and 93 ft elevations. Table A-7 of Appendix F-4 lists 136,133 acres and 224,779 acres for the coverage area at 90 feet and 93 feet respectively. Table 2 of Appendix J lists 148,553 acres and 244,088 acres for the coverage area at 90 feet and 93 feet respectively. Is there an explanation for the differences in the data sets that can be included in the final EIS report?

13. Table 3 of Appendix J is misleading as the calculations for Alternative 2 and Alternative 3 assume that the 1985 Water Control Manual remains unchanged for the Yazoo Backwater Area, which results in "unavoidable" fish and wildlife habitat impacts. There should be further investigation by MVK to understand how conceptual changes to the legacy water management plan can reduce the impact to fish and wildlife before the EIS report is finalized and an alternative is recommended. An example would be adjustments to the inflow gate closure threshold(s) at the Steele Bayou WCS as soon as the pumps are installed and available for operation.

14. Section 10.3 of Appendix J recommends the purchase of agricultural lands to offset the impacts to shorebirds. The purchase of agriculture land seems like an extreme measure in this case. MVK and MDWFP should consider partnering with willing landowners and corn/soybean farmers to set up a program like what the Arkansas Game and Fish Commission has done with their WRICE program. This would also have benefits to waterfowl and a positive impact on DUD during the winter waterfowl migration season and help provide a long-term path for meeting the Lower Mississippi Valley Joint Venture population and habitat objectives detailed on page 4 of Appendix F-4. It could also be viewed as added recreational resources if the lands were open for public hunting, which could be captured as project benefits in section 5.1.5 or the main EIS report. Opportunities to increase waterfowl habitat within the Yazoo Backwater Area should carry heavy consideration due to fall tillage farming practices in the local area that may not be accurately accounted for in the DUD calculations that are detailed within Appendix F-4.

15. On page 7 of Appendix K, there is discussion on agricultural withdrawals from the alluvial aquifer for irrigation and the subsequent lowering of the water levels being one of the main contributors to the reduction in baseflow within the Yazoo Basin. Figure 1 then goes on to show that the lower baseflow trend abruptly started in the mid to late 1970's. Are there any statistics that can be provided to directly tie the significant change in the Yazoo Basin's baseflow to a significant uptick in agricultural irrigation withdraws during that same period? Also, does MVK have a perspective on the possibility of the Yazoo Backwater levee system being a likely culprit since that phase of the project was completed in 1978, as stated on page 1 of the main EIS report, which also coincides with the significant change in the baseflow trend? If there is acknowledgement of the levees possibly being a contributing factor due to reductions in connectivity with the Mississippi River, that should be included in the EIS report and used to strengthen the business case for the installation of the pumps and timely modifications to the water management plan to allow for increased connectivity to the Mississippi River once the pumps are in place. The water management plan could then be fine-tuned using the monitoring and adaptive management methodologies summarized throughout Appendix K.

16. General Comment #1: The non-structural benefits provided by Alternative 2 or Alternative 3 in the form of flexibility provided for adaptive management and potential modifications to the Yazoo Backwater Area's water management plan appear to be understated and undervalued throughout the report. An example would be adjustments to raise the inflow gate closure threshold at the Steele Bayou WCS to allow for more connectivity to the Mississippi River and less dependence on local rainfall to ensure seasonal flood pulses on the 2-year and 5-year flood plains that would be closer to what was experienced before the earlier stages of the Yazoo Backwater Project were implemented in 1976. The comparisons to the no action Alternative 1 and non-structural Alternative 4 would be much more favorable for the pump alternatives if this was at least clearly put into context. It is understood that raising the inflow gate closure threshold would create more dependence on the pumps throughout the year and raise arguments about emissions associated with the generators but that can be countered with the fact that the mitigation plan involves wetland reforestation that would easily net out the increase in emissions through carbon sequestration.

17. General Comment #2: I agree that priority should be given to mitigation opportunities adjacent to public lands as listed in section 6.2 of Appendix J since most forested wetlands above the 5-year floodplain that would be impacted by Alternative 2 and Alternative 3 are existing public lands. This would also align with the preference for large contiguous tracts that is described on page 15 of Appendix J.

18. General Comment #3: Will the O&M costs associated with the safe and reliable operation of the pumps in Alternative 2 and Alternative 3 be susceptible to MVK budget cuts? If so, acknowledging that functionality would be exposed to federal budget cuts during the life of the project should be considered for inclusion in Table 13 of Appendix J under the Operations Phase.

19. General Comment #4: Section 8 of Appendix J lists many alternatives for mitigation that are either out of state (Arkansas and Louisiana) or outside of the YSA. Mitigation alternatives that include activities outside of the Yazoo Backwater Area should be considered for screening because they don't meet the needs for the immediate area where the project impacts are occurring.

20. General Comment #5: Once the pumps are in place, the 1985 Water Control Manual for the operation of the Steele Bayou WCS will become obsolete as that plan did not account for the pumps. The manual should be considered for updating in a timely manner and changes to the Steele Bayou WCS closure threshold(s) implemented as soon as the pumps are available for operation.

21. General Comment #6: The full utilization of Water Control Manual (1985) for operation of the Steele Bayou WCS is mentioned (5) times throughout the main EIS report but I was not able to locate the manual during a search of the internet. The manual should be included as an appendix so that the public can reference it to understand what "full utilization" implies.

22. General Comment #7: The project page where the draft EIS was posted mentions that the proposed plan allows for "increased fisheries exchange to the backwater area". It is not clearly explained how this is accomplished within the draft EIS report.

23. General Comment #8: I support Alternative 2 including the structural components of the pumps, if the existing 1985 Water Control Manual is reviewed and updated by the collaborating federal agencies in a timely manner, since that is in the best interest of wildlife and fisheries as well as the agriculture economy in the Yazoo Backwater Area. A solution that includes a pump station and robust water management plan is the right decision and would be consistent with how the other (3) backwater areas along the Lower Mississippi River are planned and operated. If a decision is made to pursue Alternative 1 or Alternative 4, it will neglect the needs of the residents in the Yazoo Backwater Area as well as continue to have a negative impact on wildlife and fisheries, which has been an issue for 46 years since the Yazoo Backwater Project was partially completed with levees, but pumps were never funded for construction. The time is right to have an overarching project in place that functions as originally planned for Mississippi. The states of Arkansas and Louisiana have been benefiting from their fully functional projects since 1977 (Huxtable pump station) and 1986 (Tensas-Cocodrie pump station) respectively.

From: Alan Bagby
To: YazooBackwater MVK
Subject: [Non-DoD Source] Yazoo Backwater Project
Date: Tuesday, July 16, 2024 9:09:37 PM

Dear Sir or Madam,

I would like to express my deepest concern for the finishing of the Yazoo Backwater Project. It’s been ongoing for my entire lifetime and I cannot understand why it hasn’t been completed yet. Even after the destruction of the 2019 flood. It’s still not completed. The groundwork has been in place for years. Please finish this project and install the pumps to protect the residents of this affected area.

Thank you,

Alan Bagby
Sent from my iPhone

From:	bill lauderdale
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Yazoo Backwater Pumps
Date:	Wednesday, July 10, 2024 8:08:59 PM

I am a 5th generation Vicksburger and 2nd generation owner of property on the bank of Eagle Lake. I remember when the Yazoo backwater project began and watched dirt being moved and concrete being poured. I also remember how excited we were to have the Federal Government helping us to keep from flooding! Needless to say, myself and many others that utilize the Yazoo Basin have been highly disappointed and have suffered many hardships from flooding that could have been prevented if only this project had been completed!
I served for 24 years as a County Supervisor in Warren County MS and I am completely shocked that our Federal Elected officials and their minions would let outside special interest groups sway them to not complete such an important flood prevention project. Please do not hesitate any longer to finish this project and install the pumps!
Thank you,
William F. Lauderdale, Jr.

Sent from my iPhone

From: Billy Magee
To: YazooBackwater MVK
Subject: [Non-DoD Source] Yazoo Pump Project
Date: Friday, July 5, 2024 8:46:26 AM

These pumps are crucial for the environment and human safety! Finish the pumps please!

From: Blake Ward
To: YazooBackwater MVK
Subject: [Non-DoD Source] Yazoo Pump Project Landowner Comment
Date: Tuesday, August 27, 2024 12:13:48 PM

Good afternoon.

I will resubmit my original letter from one of the many comment periods in the past.

I am a landowner in Onward, MS and operate 3 businesses in the flood zone and approximately 15 miles north of the proposed pump site. My grandfather cleared our land in 1947 and we have lived, farmed, hunted, and improved those 1450=/- acres now for the last 76 years. My grandfather built and operated the first country grain elevator in Mississippi for many years on the corner of Highway 61 and Blanton Road. We have a long history there and I have managed the land ever since his passing 35 years ago. In 1998 I created another company called South Delta Hunting Club, Inc. in which I lease our homes and land out to hunters on an annual basis. In 2015 I formed another company, Delta Precision Shooting, LLC, which teaches marksmanship to both civilians and military personnel. All 3 companies operate in the Yazoo Backwater zone, and it has been extremely difficult. My property ranges from 84-100' elevation and we deal with varying levels of flooding nearly every year. Like most landowners, I have already turned the land below 87' into bottomland hardwood conservation easements such as CRP or WRP and the remaining land is still farmland. When the backwater rises above 87', my hunting business suffers while the deer and other animals are forced out of their habitat, the duck's food is too far below the surface of the water for them to eat, my farmland floods which decreases its productivity and value, and the shooting range is flooded which closes the school. In 2019 I suffered approximately $300,000.00 in lost revenue from this preventable, man-made catastrophe and received a compensation check for $12 (twelve) dollars from the USDA in return. Thank you for coming together with multiple other groups and finally pushing this project forward after its initial authorization 82 years ago. Please consider lowering the pumping elevation to 87' and widen the planting window... not to eliminate - but to reduce agricultural losses to a reasonable level. Wildlife and plants will still suffer even at that level, but I know that trying to lower it below 87' will not be politically feasible due to outside interests. This project is desperately needed and has my full support. I will be more than happy to provide you with more information should you request it.

Sincerely,
Blake Ward
601-613-6609

From:	Ann Dahl
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] YBW Comments
Date:	Monday, July 1, 2024 11:37:05 AM

I wish that I had kept count of how many times you have asked me for comments or how many meetings I have attended with you.
Nothing has changed since the 2008 veto of this project or the devastating 2019 flood except that the flooding has gotten more frequent, longer in duration.
The devastation to the residents, environment and wildlife did not have to happen and should never happen again.
The project has gotten more expensive every year that it has been delayed and that will be one of our opponents rational to stop it even though it is their fault!
You have heard our stories, seen our pictures and our tears. What you have not done is feel our pain.
Stop wasting our time and money and finally finish the job you were tasked with doing over 40 years ago - finish the Yazoo Backwater Pump Project.
Ann Dahl
Eagle Lake, MS

From:	Whittington, Andy
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] YBW EIS comments
Date:	Tuesday, August 27, 2024 2:52:10 PM
Attachments:	2024 YBW EIS comments.pdf

Please see the attached comments from the Mississippi Farm Bureau Federation.

Andy Whittington
Environmental Programs Coordinator
Mississippi Farm Bureau® Federation
P.O. Box 1972
Jackson, Mississippi 39215
Office: 601-977-4238
Cell: 601-665-7885
awhittington@msfb.org

Our mission is to create an environment in which Mississippi farmers, ranchers, and Farm Bureau® members can have a better life and make a better living.

FARM BUREAU MISSISSIPPI ®

MISSISSIPPI FARM BUREAU® FEDERATION

Post Office Box 1972, Jackson, Mississippi 39215-1972 601-957-3200

August 26, 2024

Attention: CEMVK-PPMD
Vicksburg District, U.S. Army Corps of Engineers
4155 East Clay Street
Vicksburg, Mississippi, 39183

To whom it may concern,

On behalf of the Mississippi Farm Bureau Federation (MFBF), I appreciate this opportunity to express our **support for Alternative 2 (Crop Season 16 March – 15 October and Non-crop Season 16 October – 15 March).** MFBF is a grassroots, general agriculture organization representing over 170,000 farm family members and 17 recognized commodities. Many of our members live, work, or farm in Sharkey and Issaquena County and have experienced significant Yazoo Backwater flooding. The area is desperate for relief.

While not perfect, **MFBF believes that Alternative 2 is the best option** of the four alternatives presented. Alternatives 1 and 4 are not acceptable alternatives and provide little to no protection. Our members would prefer that Crop Season dates began on March 1 and that the pumps began operation at 87'. Alternative 3 is a viable, but less desirable option. Research has shown that early-planted corn yields are higher from less insect pressure, and requires less irrigation. MFBF would like to see "voluntary" acquisition of 101 structures below 90' and would prefer that land acquisition for mitigation was done through easements rather than fee title. The land easement would allow for mitigation, but the land would still be providing tax revenue for the county. When compared to the other Alternatives, our members believe that Alternative 2 provides the most viable option to protect homes, wildlife and ecosystems.

Please consider these comments as reflecting the opinions of the people who live, work, and depend on the Yazoo Backwater area. We understand that there is a lot of interest from others outside of the backwater area. They have never experienced a flood, or seen wildlife trapped and die on a levee. This problem was created by the failure to finish the MR&T project as it was designed. Now is the time to rectify the problem, provide some relief to wildlife, landowners, and citizens, and Alternative 2 is the most appropriate option.

Sincerely,

Andy Whittington
Environmental Programs Coordinator

From:	Vicksburg District Public Affairs
To:	YazooBackwater MVK
Cc:	Vicksburg District Public Affairs; Escobedo, Rory E CIV (USA)
Subject:	FW: [Non-DoD Source] Pumps input
Date:	Tuesday, July 23, 2024 8:09:33 AM

This one came to our inbox yesterday so passing along.

Erin Hern
Deputy Chief, Public Affairs Office
U.S. Army Corps of Engineers, Vicksburg District
Office: 601.631.5208
Mobile: 769.272.3606
Erin.A.Hern@usace.army.mil

-----Original Message-----
From: Charles Brasfeild <brasfeildc@yahoo.com>
Sent: Monday, July 22, 2024 7:17 PM
To: Vicksburg District Public Affairs <vicksburgdistrict@usace.army.mil>
Subject: [Non-DoD Source] Pumps input

I am not able to attend any of the meetings scheduled for this week but would like to provide these comments:
The I remember before the Steele Bayou structure and the canal were built the south delta residents were told that after the structure was completed in 1969 a follow on project would install a pump system to remove flood waters above a certain level. Studies were still being conducted to determine the best elevation to limit the water level upstream of the structure. I attended the first meeting held in Rolling Fork. I don't recall the date of that meeting but it was about 55 years ago. From that time forward out of state so called "conservation" groups have been loud opponents. I graduated from MSUs College of Engineering in 1969. Several family members had careers with the Army Corps of Engineers at WES/ERDC. I retired from ERDC . In the past 55 years I have never talked with a local engineer or south delta farmer that did not support the pumps. They are the individuals that best understand the pros & cons of the pumps. Many have attended multiple meetings and voiced opinions supporting the pumps. I sincerely hope that the politicians who have to pass the funding bills will listen to our voices this time.
Very Respectfully,
Charles W Brasfeild, Jr.
Brasfeildc@yahoo.com
601-631-4716

COMMENT CARD

5

Yazoo Backwater Area Water Management DEIS Public Meeting

* Please note all fields are optional.

Name: Presley Gates Phone: 762-207-4153

Address: 314 Austin Loop Ft. Moore, GA 31905 Email: presleyauer3@gmail

AREAS OF CONCERN

* Check all that apply.

- [x] Home Accessibility
- [x] Housing or Property Impact
- [x] Access to Emergency Services
- [x] Impacts to Wildlife
- [x] Impacts the wetlands/environment
- [x] Infrastructure (Electricity or Road Accessibility)
- [x] Agriculture (Flooding of Farmland or Loss of Livestock)
- [x] Hunting or Outdoor Recreation
- [ ] Other: ____

COMMENTS, QUESTIONS OR SUGGESTIONS:

We are in favor of alternative #2. Please consider tweaking the pump on date & elevation level.

7

COMMENT CARD

Yazoo Backwater Area Water Management
DEIS Public Meeting

* Please note all fields are optional.

Name: Claiborne D Adcock, Jr.
Phone: (662) 571-2077

Address: Decatur, GA 30033
Email: claiborne.adcock@gmail.com

AREAS OF CONCERN

* Check all that apply.

- [x] Home Accessibility
- [x] Housing or Property Impact
- [x] Access to Emergency Services
- [x] Impacts to Wildlife
- [x] Impacts the wetlands/environment
- [x] Infrastructure (Electricity or Road Accessibility)
- [x] Agriculture (Flooding of Farmland or Loss of Livestock)
- [x] Hunting or Outdoor Recreation
- [ ] Other: ____________________

COMMENTS, QUESTIONS OR SUGGESTIONS:

I'm a landowner in the YBW area & support Alternative #2 with attention to possible adjustments for pump turn-on dates & turn-on elevation

COMMENT CARD

4

Yazoo Backwater Area Water Management
DEIS Public Meeting

* Please note all fields are optional.

Name: Charles Auer

Phone: 706-682-0490

1030 Christmas Ct

Address: Midland, GA 31820

rangerauer@gmail.com

Email:

AREAS OF CONCERN

* Check all that apply.

- [x] Home Accessibility
- [x] Housing or Property Impact
- [x] Access to Emergency Services
- [x] Impacts to Wildlife
- [ ] Other: ______
- [x] Impacts the wetlands/environment
- [x] Infrastructure (Electricity or Road Accessibility)
- [x] Agriculture (Flooding of Farmland or Loss of Livestock)
- [x] Hunting or Outdoor Recreation

COMMENTS, QUESTIONS OR SUGGESTIONS:

We're in favor of alternate #2.

COMMENT CARD

Yazoo Backwater Area Water Management DEIS Public Meeting

* Please note all fields are optional.

Name: Joy Boyd

Phone:

Address: 559 Boyd Rd Holly Bluff, MS 39088

Email: JoyKBoyd@BellSouth.net

AREAS OF CONCERN

* Check all that apply.

- [x] Home Accessibility
- [x] Housing or Property Impact
- [x] Access to Emergency Services
- [x] Impacts to Wildlife
- [x] Impacts the wetlands/environment
- [x] Infrastructure (Electricity or Road Accessibility)
- [x] Agriculture (Flooding of Farmland or Loss of Livestock)
- [x] Hunting or Outdoor Recreation
- [ ] Other: ______

COMMENTS, QUESTIONS OR SUGGESTIONS:

I'm in favor of alternative #2. Please consider the pump-on date and elevation level.

COMMENT CARD

2

Yazoo Backwater Area Water Management
DEIS Public Meeting

* Please note all fields are optional.

Name: LAURA AUER

Phone: 706-682-0490

1030 Christmas Ct

auersx6@yahoo.com

Address: Midland, GA 31820

Email:

AREAS OF CONCERN

* Check all that apply.

- [x] Home Accessibility
- [x] Housing or Property Impact
- [x] Access to Emergency Services
- [x] Impacts to Wildlife
- [x] Other: ______
- [x] Impacts the wetlands/environment
- [x] Infrastructure (Electricity or Road Accessibility)
- [x] Agriculture (Flooding of Farmland or Loss of Livestock)
- [x] Hunting or Outdoor Recreation

COMMENTS, QUESTIONS OR SUGGESTIONS:

We are in Favor of alternate #2

COMMENT CARD

Yazoo Backwater Area Water Management DEIS Public Meeting

* Please note all fields are optional.

Name: Grant Auer

Phone: 762·207·4152

Email: grant.auerb@gmail.com

Address: 15 11th Street Columbus, GA 31901

AREAS OF CONCERN

* Check all that apply.

- [x] Home Accessibility
- [x] Housing or Property Impact
- [x] Access to Emergency Services
- [x] Impacts to Wildlife
- [x] Impacts the wetlands/environment
- [x] Infrastructure (Electricity or Road Accessibility)
- [x] Agriculture (Flooding of Farmland or Loss of Livestock)
- [x] Hunting or Outdoor Recreation
- [ ] Other: ______

COMMENTS, QUESTIONS OR SUGGESTIONS:

I'm in favor of alternative 2 - I also wish you would consider tweaking the pump-on date and elevation level.

6

COMMENT CARD

Yazoo Backwater Area Water Management
DEIS Public Meeting

* Please note all fields are optional.

Name: Warner Adcock

Phone: (662)571-1493

Address: 1018 McDonnell Dr. Decatur, GA 30033

Email: warner.adcock@gmail.com

AREAS OF CONCERN

* Check all that apply.

- [x] Home Accessibility
- [x] Housing or Property Impact
- [x] Access to Emergency Services
- [x] Impacts to Wildlife
- [x] Impacts the wetlands/environment
- [x] Infrastructure (Electricity or Road Accessibility)
- [x] Agriculture (Flooding of Farmland or Loss of Livestock)
- [x] Hunting or Outdoor Recreation
- [ ] Other: ___

COMMENTS, QUESTIONS OR SUGGESTIONS:

I'm a landowner and support alternative #2 with adjustments to turn-on + dates for the pumps.

RF 2pm

COMMENT CARD

Yazoo Backwater Area Water Management DEIS Public Meeting

* Please note all fields are optional.

Name: Clay Adcock

Phone: (662)571-5582

Address: 559 Boyd Rd
Holly Bluff, MS 39088

Email: clayadcock@gmail.com

AREAS OF CONCERN

* Check all that apply.

- [x] Home Accessibility
- [x] Housing or Property Impact
- [x] Access to Emergency Services
- [x] Impacts to Wildlife
- [x] Impacts the wetlands/environment
- [x] Infrastructure (Electricity or Road Accessibility)
- [x] Agriculture (Flooding of Farmland or Loss of Livestock)
- [x] Hunting or Outdoor Recreation
- [ ] Other: ___

COMMENTS, QUESTIONS OR SUGGESTIONS:

Given the choices Alternative #2 is preferred.

Please hurry - we have been drowning for 40+ years!

RF 2pm

COMMENT CARD

Yazoo Backwater Area Water Management
DEIS Public Meeting

* Please note all fields are optional.

Name: Henry Reeves

Phone: 662 828 3284

Address: Holly Bluff MS

Email:

AREAS OF CONCERN

* Check all that apply.

- [x] Home Accessibility
- [x] Housing or Property Impact
- [x] Access to Emergency Services
- [x] Impacts to Wildlife
- [x] Impacts the wetlands/environment
- [x] Infrastructure (Electricity or Road Accessibility)
- [x] Agriculture (Flooding of Farmland or Loss of Livestock)
- [x] Hunting or Outdoor Recreation
- [x] Other: ______

COMMENTS, QUESTIONS OR SUGGESTIONS:

Finish the pumps

RF 2pm

COMMENT CARD

Yazoo Backwater Area Water Management
DEIS Public Meeting

* Please note all fields are optional.

Name: Ann Reeves

Phone:

Address: Holly Bluff

Email:

AREAS OF CONCERN

* Check all that apply.

- [x] Home Accessibility
- [x] Housing or Property Impact
- [x] Access to Emergency Services
- [x] Impacts to Wildlife
- [x] Impacts the wetlands/environment
- [x] Infrastructure (Electricity or Road Accessibility)
- [x] Agriculture (Flooding of Farmland or Loss of Livestock)
- [ ] Hunting or Outdoor Recreation
- [ ] Other: ______

COMMENTS, QUESTIONS OR SUGGESTIONS:

RF 2pm

COMMENT CARD

Yazoo Backwater Area Water Management
DEIS Public Meeting

* Please note all fields are optional.

Name: Jeffry Mitchell

Phone: (662) 873 - 4733

Address: PO Box 209 Cary MS 39054

Email: jeffrymitchell@hotmail.com

AREAS OF CONCERN

* Check all that apply.

- [x] Home Accessibility
- [x] Housing or Property Impact
- [x] Access to Emergency Services
- [x] Impacts to Wildlife
- [x] Impacts the wetlands/environment
- [x] Infrastructure (Electricity or Road Accessibility)
- [x] Agriculture (Flooding of Farmland or Loss of Livestock)
- [x] Hunting or Outdoor Recreation
- [ ] Other: ______

COMMENTS, QUESTIONS OR SUGGESTIONS:

Cropping Season is wrong should start March 1 when crop insurance and I personally think elevation is to high for wildlife and farming should be 87 to 90 instead 90 & 93

RF 2pm

COMMENT CARD

Yazoo Backwater Area Water Management
DEIS Public Meeting

* Please note all fields are optional.

Name: Charles Perry

Phone: 662-571-3672

Address:

Email: p.chuck70@yahoo

AREAS OF CONCERN

* Check all that apply.

- [x] Home Accessibility
- [x] Housing or Property Impact
- [x] Access to Emergency Services
- [x] Impacts to Wildlife
- [ ] Impacts the wetlands/environment
- [x] Infrastructure (Electricity or Road Accessibility)
- [x] Agriculture (Flooding of Farmland or Loss of Livestock)
- [x] Hunting or Outdoor Recreation
- [ ] Other: ____

COMMENTS, QUESTIONS OR SUGGESTIONS:

WE Need the pumps to complete the original Deal

RF 2pm

COMMENT CARD

Yazoo Backwater Area Water Management DEIS Public Meeting

* Please note all fields are optional.

Name: Gale Perry

Phone: 662-571-7503

Address: 2705 Satartia Rd, Yazoo City.

Email: galecobbie@gmail.com

AREAS OF CONCERN

* Check all that apply.

- [x] Home Accessibility
- [x] Housing or Property Impact
- [x] Access to Emergency Services
- [x] Impacts to Wildlife
- [x] Impacts the wetlands/environment
- [x] Infrastructure (Electricity or Road Accessibility)
- [x] Agriculture (Flooding of Farmland or Loss of Livestock)
- [x] Hunting or Outdoor Recreation
- [ ] Other: ______

COMMENTS, QUESTIONS OR SUGGESTIONS:

Build the pumps

RF 2pm

COMMENT CARD

Yazoo Backwater Area Water Management DEIS Public Meeting

* Please note all fields are optional.

Name: Thomas Jones III

Phone: 662-571-3659

Address: P.O. Box 35 H.B. Ms

Email:

AREAS OF CONCERN

* Check all that apply.

- [x] Home Accessibility
- [x] Housing or Property Impact
- [ ] Access to Emergency Services
- [x] Impacts to Wildlife
- [ ] Impacts the wetlands/environment
- [ ] Infrastructure (Electricity or Road Accessibility)
- [x] Agriculture (Flooding of Farmland or Loss of Livestock)
- [ ] Hunting or Outdoor Recreation
- [ ] Other: ______

COMMENTS, QUESTIONS OR SUGGESTIONS:

RF 2pm

COMMENT CARD

Yazoo Backwater Area Water Management DEIS Public Meeting

* Please note all fields are optional.

Name: Gene Ford

Phone: 601-831-2800

Address: 12370 HWY 1 Rolling Fork 39159

Email: gene_ford_jr@yahoo.com

AREAS OF CONCERN

* Check all that apply.

- ☐ Home Accessibility
- ☒ Housing or Property Impact
- ☒ Access to Emergency Services
- ☒ Impacts to Wildlife
- ☒ Impacts the wetlands/environment
- ☒ Infrastructure (Electricity or Road Accessibility)
- ☒ Agriculture (Flooding of Farmland or Loss of Livestock)
- ☒ Hunting or Outdoor Recreation
- ☐ Other: ______

COMMENTS, QUESTIONS OR SUGGESTIONS:

Option # 2

Please

RF 2pm

COMMENT CARD

Yazoo Backwater Area Water Management DEIS Public Meeting

* Please note all fields are optional.

Name: Leslie Miller

Phone: 662-873-7510

Address: 354 E. Race St. Rolling Fork, MS 39159

Email: lkmiller@bellsouth.net

AREAS OF CONCERN

* Check all that apply.

- ☐ Home Accessibility
- ☐ Housing or Property Impact
- ☒ Access to Emergency Services
- ☒ Impacts to Wildlife
- ☒ Impacts the wetlands/environment
- ☒ Infrastructure (Electricity or Road Accessibility)
- ☒ Agriculture (Flooding of Farmland or Loss of Livestock)
- ☒ Hunting or Outdoor Recreation
- ☐ Other: ______

COMMENTS, QUESTIONS OR SUGGESTIONS:

KF 2pm

COMMENT CARD

Yazoo Backwater Area Water Management DEIS Public Meeting

* Please note all fields are optional.

Name: Concern Citizen

Phone:

Address:

Email:

AREAS OF CONCERN

* Check all that apply.

- ☐ Home Accessibility
- ☐ Impacts the wetlands/environment
- ☐ Housing or Property Impact
- ☐ Infrastructure (Electricity or Road Accessibility)
- ☐ Access to Emergency Services
- ☐ Agriculture (Flooding of Farmland or Loss of Livestock)
- ☐ Impacts to Wildlife
- ☐ Hunting or Outdoor Recreation
- ☐ Other: ______

COMMENTS, QUESTIONS OR SUGGESTIONS:

I am for any alternative that will provide an opportunity for economic growth that is not totally dependent on Agriculture and the generation wealth that has dominate the delta

Rolling Fork 2pm

COMMENT CARD

Yazoo Backwater Area Water Management DEIS Public Meeting

* Please note all fields are optional.

Name: Velvet Hollowell

Phone: 601-642-4275

Address: 407 Sea Island Dr
Vicksburg, MS 39183
(Eagle Lake)

Email:

AREAS OF CONCERN

* Check all that apply.

- ☐ Home Accessibility
- ☑ Housing or Property Impact
- ☐ Access to Emergency Services
- ☑ Impacts to Wildlife
- ☐ Impacts the wetlands/environment
- ☐ Infrastructure (Electricity or Road Accessibility)
- ☐ Agriculture (Flooding of Farmland or Loss of Livestock)
- ☐ Hunting or Outdoor Recreation
- ☐ Other: ______

COMMENTS, QUESTIONS OR SUGGESTIONS:

We purchased our forever home in 2019 & 6 months later we had 4 1/2 feet of water inside our home!
PLEASE - VOTE Project #2 -

Thank you,
Mr & Mrs Hollowell

Rolling Fork 6pm

COMMENT CARD

Yazoo Backwater Area Water Management DEIS Public Meeting

* Please note all fields are optional.

Name: Luke Richards

Phone: 662-590-2653

Address: 1402 Barnwell Circle, Yazoo City, MS 39194

Email: Lukerichards2340@gmail.com

AREAS OF CONCERN

* Check all that apply.

- [x] Home Accessibility
- [x] Housing or Property Impact
- [x] Access to Emergency Services
- [x] Impacts to Wildlife
- [ ] Impacts the wetlands/environment
- [x] Infrastructure (Electricity or Road Accessibility)
- [x] Agriculture (Flooding of Farmland or Loss of Livestock)
- [ ] Hunting or Outdoor Recreation
- [ ] Other: ______

COMMENTS, QUESTIONS OR SUGGESTIONS:

Economic impacts grow year by year; widening the poverty gap between here and already impoverished MS

Loss of Culture (former Native American, Blues/Delta) + population

The only people left will be rich landowners and those too poor to move

Rolling Fork 6pm

COMMENT CARD

Yazoo Backwater Area Water Management
DEIS Public Meeting

* Please note all fields are optional.

Name: Janet Whitfield

Phone: 662-303-3407

Address: 8710 Hwy. 1 Rolling Fork

Email: janetwhitfield68@yahoo.com

AREAS OF CONCERN

* Check all that apply.

- [ ] Home Accessibility
- [ ] Housing or Property Impact
- [x] Access to Emergency Services
- [x] Impacts to Wildlife
- [x] Impacts the wetlands/environment
- [x] Infrastructure (Electricity or Road Accessibility)
- [x] Agriculture (Flooding of Farmland or Loss of Livestock)
- [x] Hunting or Outdoor Recreation
- [x] Other: My home is affected by the backwater flooding on one side and the relief well water on the other, as

COMMENTS, QUESTIONS OR SUGGESTIONS:

well as seepwater. (I live within 100 yds. from the ft. of the MS River levee.) My family has been in that location for 140 yrs. We are at the extreme top of the backwater area, but so many of our friends & family suffer from the flooding more often than we ever like to think about.

RF 10am

COMMENT CARD

Yazoo Backwater Area Water Management
DEIS Public Meeting

* Please note all fields are optional.

Name: Sharon Price

Phone: 662 873 7552

Address: 84 Laurel St Anguilla, MS 38721

Email: jawsprice56@yahoo.com

AREAS OF CONCERN

* Check all that apply.

- [x] Home Accessibility
- [x] Housing or Property Impact
- [x] Access to Emergency Services
- [x] Impacts to Wildlife
- [x] Impacts the wetlands/environment
- [x] Infrastructure (Electricity or Road Accessibility)
- [x] Agriculture (Flooding of Farmland or Loss of Livestock)
- [x] Hunting or Outdoor Recreation
- [ ] Other: ____________________

COMMENTS, QUESTIONS OR SUGGESTIONS:

RF 10am

COMMENT CARD

Yazoo Backwater Area Water Management DEIS Public Meeting

* Please note all fields are optional.

Name: George Weather

Phone: 662 822-6173

Address: 112 Bayou Rd Greenville, MS

Email: Weatherschip9@Gmail

AREAS OF CONCERN

* Check all that apply.

- [x] Home Accessibility
- [x] Housing or Property Impact
- [x] Access to Emergency Services
- [x] Impacts to Wildlife
- [x] Impacts the wetlands/environment
- [x] Infrastructure (Electricity or Road Accessibility)
- [x] Agriculture (Flooding of Farmland or Loss of Livestock)
- [x] Hunting or Outdoor Recreation
- [x] Other: Forestry damage

30 yR for saw log without damage

COMMENTS, QUESTIONS OR SUGGESTIONS:

RF 10am

COMMENT CARD

Yazoo Backwater Area Water Management DEIS Public Meeting

* Please note all fields are optional.

Name: Rebecca Diffey

Phone: 662-907-0356

Address: 1199 Front Street Anguilla, MS 38721

Email: gdiffey@aol.com

AREAS OF CONCERN

* Check all that apply.

- [ ] Home Accessibility
- [x] Housing or Property Impact
- [x] Access to Emergency Services
- [x] Impacts to Wildlife
- [x] Impacts the wetlands/environment
- [ ] Infrastructure (Electricity or Road Accessibility)
- [x] Agriculture (Flooding of Farmland or Loss of Livestock)
- [x] Hunting or Outdoor Recreation
- [ ] Other: ____________________

COMMENTS, QUESTIONS OR SUGGESTIONS:

I feel as though this issue has been seen as farmers against the environmentalist, with the environmentalists championing the animals. The reality is that the 2019 flooding was horrible and destructive for the wildlife and the flora.

RF 10am

COMMENT CARD

Yazoo Backwater Area Water Management DEIS Public Meeting

* Please note all fields are optional.

Name: James G Newman

Phone: 662-907-1126

Address: P.O. Box 326 Rolling Fork, MS 39159

Email: jgnoe@yahoo.com

AREAS OF CONCERN

* Check all that apply.

- [ ] Home Accessibility
- [x] Housing or Property Impact
- [x] Access to Emergency Services
- [x] Impacts to Wildlife
- [ ] Impacts the wetlands/environment
- [x] Infrastructure (Electricity or Road Accessibility)
- [x] Agriculture (Flooding of Farmland or Loss of Livestock)
- [x] Hunting or Outdoor Recreation
- [ ] Other: ______

COMMENTS, QUESTIONS OR SUGGESTIONS:

Alternative 2D from March 16 is what our Delta needs

RF 10am

COMMENT CARD

Yazoo Backwater Area Water Management DEIS Public Meeting

* Please note all fields are optional.

Name: Eddie HAtchen

Phone: 662-873-7800

Address: 37320 Hwy 465 Rolling Fork MS 39159

Email: EddieHAtchen027@yAhoo.com

AREAS OF CONCERN

* Check all that apply.

- [x] Home Accessibility
- [x] Housing or Property Impact
- [x] Access to Emergency Services
- [x] Impacts to Wildlife
- [x] Impacts the wetlands/environment
- [x] Infrastructure (Electricity or Road Accessibility)
- [x] Agriculture (Flooding of Farmland or Loss of Livestock)
- [x] Hunting or Outdoor Recreation
- [ ] Other: ______________________

COMMENTS, QUESTIONS OR SUGGESTIONS:

RF 10am

COMMENT CARD

Yazoo Backwater Area Water Management
DEIS Public Meeting

* Please note all fields are optional.

Name: John Phillips

Phone: 662-571-7107

Address: 4042 Hwy16 W Yazoo City, 39194

Email: jfp@phillipsfarms.us

AREAS OF CONCERN

* Check all that apply.

- [x] Home Accessibility
- [x] Housing or Property Impact
- [x] Access to Emergency Services
- [x] Impacts to Wildlife
- [x] Impacts the wetlands/environment
- [x] Infrastructure (Electricity or Road Accessibility)
- [x] Agriculture (Flooding of Farmland or Loss of Livestock)
- [x] Hunting or Outdoor Recreation
- [x] Other: inequality of man-made flooding

COMMENTS, QUESTIONS OR SUGGESTIONS:

Install the pumps & operate in accordance with option 2 ASAP –

RF 10am

COMMENT CARD

Yazoo Backwater Area Water Management DEIS Public Meeting

* Please note all fields are optional.

Name: Josh Miller

Phone: 662-907-3014

Address: 301 W. Lakewood Dr. Yazoo City, MS

Email: jkm1272@gmail.com

AREAS OF CONCERN

* Check all that apply.

- [ ] Home Accessibility
- [x] Housing or Property Impact
- [ ] Access to Emergency Services
- [x] Impacts to Wildlife
- [x] Impacts the wetlands/environment
- [x] Infrastructure (Electricity or Road Accessibility)
- [x] Agriculture (Flooding of Farmland or Loss of Livestock)
- [x] Hunting or Outdoor Recreation
- [ ] Other: ______

COMMENTS, QUESTIONS OR SUGGESTIONS:

Please Support Alt. #2

RF 10am

COMMENT CARD

Yazoo Backwater Area Water Management
DEIS Public Meeting

* Please note all fields are optional.

Name: Jane Windham

Phone: 662-873-3517

Address: 638 S 4th St. Rolling Fork 39159

Email: janewindham70@gmail.com

AREAS OF CONCERN

* Check all that apply.

- [x] Home Accessibility
- [ ] Housing or Property Impact
- [x] Access to Emergency Services
- [x] Impacts to Wildlife
- [ ] Impacts the wetlands/environment
- [x] Infrastructure (Electricity or Road Accessibility)
- [x] Agriculture (Flooding of Farmland or Loss of Livestock)
- [ ] Hunting or Outdoor Recreation
- [ ] Other: ______

COMMENTS, QUESTIONS OR SUGGESTIONS:

I have been employed for 50 years in Health Care in Sharkey County. In 2019 our Ambulances could not get to V'burg to transport to River Region Hospital. Our ambulances could not get to homes to answer 911 calls. We had to take out our CT machine and store it for 3 months. We could not offer adequate Medical Services that year —

KF 10am

COMMENT CARD

Yazoo Backwater Area Water Management DEIS Public Meeting

* Please note all fields are optional.

Name: Victoria Darden

Phone: 601-218-1293

Address: 661 Black Bayou Rd. Rolling Fork, MS 39159

Email: torilyn09@gmail.com

AREAS OF CONCERN

* Check all that apply.

- [x] Home Accessibility
- [ ] Housing or Property Impact
- [x] Access to Emergency Services
- [x] Impacts to Wildlife
- [x] Impacts the wetlands/environment
- [x] Infrastructure (Electricity or Road Accessibility)
- [x] Agriculture (Flooding of Farmland or Loss of Livestock)
- [x] Hunting or Outdoor Recreation
- [ ] Other: ______

COMMENTS, QUESTIONS OR SUGGESTIONS:

I support alternative 2. We need this Pumping station Built not only for the people but for the animals + enviroment as well!

Finish The Pumps!!

RF 10am

COMMENT CARD

Yazoo Backwater Area Water Management DEIS Public Meeting

* Please note all fields are optional.

Name: Gene Boykin

Phone:

Address: 159 Willette Rd Rolling Fork, MS

Email: gboykin@msdeltawireless.com

AREAS OF CONCERN

* Check all that apply.

- [ ] Home Accessibility
- [ ] Housing or Property Impact
- [ ] Access to Emergency Services
- [ ] Impacts to Wildlife
- [ ] Impacts the wetlands/environment
- [ ] Infrastructure (Electricity or Road Accessibility)
- [x] Agriculture (Flooding of Farmland or Loss of Livestock)
- [ ] Hunting or Outdoor Recreation
- [ ] Other: ______

COMMENTS, QUESTIONS OR SUGGESTIONS:

My fear is on March 16 Water is at 93 ft. The powers at be at the meeting said it took 6 to 7 days to pump a foot of elevation. If 3 ft we are talking 18 days to get to 90 ft which is after April 1st. We are at tale end of corn planting season and ground still has to dry up. We need a lower starting point than 93 ft.

Rolling Fork 10a

COMMENT CARD

Yazoo Backwater Area Water Management DEIS Public Meeting

* Please note all fields are optional.

Name: Charles Weissinger

Phone: 662-873-6258

Address: PO Box 306 Rolling Fork MS 39159

Email: cweissinger@bellsouth.net

AREAS OF CONCERN

* Check all that apply.

- [x] Home Accessibility
- [x] Housing or Property Impact
- [x] Access to Emergency Services
- [x] Impacts to Wildlife
- [x] Impacts the wetlands/environment
- [x] Infrastructure (Electricity or Road Accessibility)
- [x] Agriculture (Flooding of Farmland or Loss of Livestock)
- [x] Hunting or Outdoor Recreation
- [ ] Other: ______

COMMENTS, QUESTIONS OR SUGGESTIONS:

Levee on West bank of MS River acts as a dam as overflow water naturally goes west during a flood. Water is now artificially impounded on the east bank of the MS River. Each water event is a separate taking.


Rolling Fork
10am

Vining 2pm

COMMENT CARD

Yazoo Backwater Area Water Management
DEIS Public Meeting

* Please note all fields are optional.

Name: Tisha Boyanton

Phone: 601-941-3519

Address:

Email: tisha.boyanton@gmail.com

AREAS OF CONCERN

* Check all that apply.

- [x] Home Accessibility
- [x] Housing or Property Impact
- [x] Access to Emergency Services
- [x] Impacts to Wildlife
- [x] Impacts the wetlands/environment
- [x] Infrastructure (Electricity or Road Accessibility)
- [x] Agriculture (Flooding of Farmland or Loss of Livestock)
- [x] Hunting or Outdoor Recreation
- [ ] Other: ____

COMMENTS, QUESTIONS OR SUGGESTIONS:

Option 2 –

[illegible] 2pm

COMMENT CARD

Yazoo Backwater Area Water Management DEIS Public Meeting

* Please note all fields are optional.

Name: Beverly
Rev. ~~[illegible]~~ BaskIN

Phone: 601-953-7219

Address: Church@ 745 Hutson St
Property@ 3435 N. Washington

Email: baskin_beverly@yahoo.com

AREAS OF CONCERN

* Check all that apply.

- [ ] Home Accessibility
- [x] Housing or Property Impact
- [ ] Access to Emergency Services
- [ ] Impacts to Wildlife
- [ ] Impacts the wetlands/environment
- [ ] Infrastructure (Electricity or Road Accessibility)
- [ ] Agriculture (Flooding of Farmland or Loss of Livestock)
- [ ] Hunting or Outdoor Recreation
- [ ] Other: ______________________________

COMMENTS, QUESTIONS OR SUGGESTIONS:

Vmuy 7pm

COMMENT CARD

Yazoo Backwater Area Water Management
DEIS Public Meeting

* Please note all fields are optional.

Name: Rev. Johnny Baskin, Jr.

Phone: 601-672-5230

Address: Church @ 745 Hutson St Lot@ 3435 N. Washington

Email: jsteelmanb@bellsouth.net

AREAS OF CONCERN

* Check all that apply.

- ☐ Home Accessibility
- ☑ ~~Housing~~ or Property Impact
- ☐ Access to Emergency Services
- ☐ Impacts to Wildlife
- ☐ Impacts the wetlands/environment
- ☐ Infrastructure (Electricity or Road Accessibility)
- ☐ Agriculture (Flooding of Farmland or Loss of Livestock)
- ☐ Hunting or Outdoor Recreation
- ☐ Other: ______

COMMENTS, QUESTIONS OR SUGGESTIONS:

Vmm 2pm

COMMENT CARD

Yazoo Backwater Area Water Management
DEIS Public Meeting

* Please note all fields are optional.

Name: letha Taylor

Phone: 901-240-7418

Address: PO Box 122 Cary MS 39054

Email: letha99@hotmail.com

AREAS OF CONCERN

* Check all that apply.

- [x] Home Accessibility
- [x] Housing or Property Impact
- [x] Access to Emergency Services
- [x] Impacts to Wildlife
- [x] Impacts the wetlands/environment
- [x] Infrastructure (Electricity or Road Accessibility)
- [x] Agriculture (Flooding of Farmland or Loss of Livestock)
- [x] Hunting or Outdoor Recreation
- [ ] Other: ______

I AM A Retired Navy Vet and a current USACE employee... And I just WANT to go home!

COMMENTS, QUESTIONS OR SUGGESTIONS:

My home is located on 4047 Goose Lake Road in Fitler. I am unable to easily get to my house due to the Bridge closure for 3 yrs, and my Natural gas services was cut, without Any Notification. The Alternate Roads are terrible, and takes too long to get in and out of there. I have been out of my house since MAR 2, 2019. I WANT to go home but I need, at least the bridge fixed to do so. Others would come back if Access was ~~better~~ Not so Challenging.

Vmmy 2pm

COMMENT CARD

Yazoo Backwater Area Water Management
DEIS Public Meeting

* Please note all fields are optional.

Name: Jackie H Kerr

Phone: 662-820-4783

Address: mailing 12315 Hwy 1 Rolling Fork MS 39159 / Resident 6654 ATTALA CO Hwy 14 Goodman MS 39079

Email:

AREAS OF CONCERN

* Check all that apply.

- [ ] Home Accessibility
- [ ] Housing or Property Impact
- [ ] Access to Emergency Services
- [x] Impacts to Wildlife
- [x] Impacts the wetlands/environment
- [ ] Infrastructure (Electricity or Road Accessibility)
- [ ] Agriculture (Flooding of Farmland or Loss of Livestock)
- [ ] Hunting or Outdoor Recreation
- [ ] Other: ______

COMMENTS, QUESTIONS OR SUGGESTIONS:

Option 2 will best allievate the problems this summer flooding is causing to our bottomland hardwood forest and wetland health in the South Delta

Vmug ypm

COMMENT CARD

Yazoo Backwater Area Water Management
DEIS Public Meeting

* Please note all fields are optional.

Name: OAkley G. DAniels

Phone: 601-831-5120

Address: 2424 Ring Rd. Vicksburg MS

Email: oAkleydanie@yahoo.com

AREAS OF CONCERN

* Check all that apply.

- [ ] Home Accessibility
- [x] Housing or Property Impact
- [ ] Access to Emergency Services
- [x] Impacts to Wildlife
- [ ] Impacts the wetlands/environment
- [ ] Infrastructure (Electricity or Road Accessibility)
- [x] Agriculture (Flooding of Farmland or Loss of Livestock)
- [x] Hunting or Outdoor Recreation
- [ ] Other: ______

COMMENTS, QUESTIONS OR SUGGESTIONS:

2011-2012? Completely Flooded > July
2018-19? > July-~~August~~ August
2019-20? > July-August
Could not Farm/no crop
Wildlife Decimated/not back to pre 2019 levels as of 7-23-24
Effect property Values
Extensive damage to marketable timber!

Vburg 7pm

COMMENT CARD

Yazoo Backwater Area Water Management DEIS Public Meeting

* Please note all fields are optional.

Name: Diane Klaus

Phone: 601-415-8838

Address: 253 Shell Beach Rd V'burg, MS 39183

Email: dmkdesigns514@gmail.com

AREAS OF CONCERN

* Check all that apply.

- [x] Home Accessibility
- [x] Housing or Property Impact
- [x] Access to Emergency Services
- [x] Impacts to Wildlife
- [x] Impacts the wetlands/environment
- [x] Infrastructure (Electricity or Road Accessibility)
- [x] Agriculture (Flooding of Farmland or Loss of Livestock)
- [x] Hunting or Outdoor Recreation
- [ ] Other: ______

COMMENTS, QUESTIONS OR SUGGESTIONS:

I fully support Alternative #2 (except a mandatory buyout) to install a pump station for better safety, quality of life and a heathy environment for ALL inhabitants

2017 OPTION #2 Vmy 2pm

Cathy: MS WILDLIFE FED

I see people are playing hardball about the pumps/no pumps issue and the Extravaganza. I am sorry to hear that. I do want to reiterate my feelings about the issue if it can help in any way.

The "pumps/no pumps" is not a cut and dry issue. As a practicing waterfowl biologist in the south delta for over 10 years, I have had my share complications with the excess water that floods the south delta due to the drainage from the Yazoo Backwater Flood Control Project, the pumps would alleviate this problem. I do understand the big question of "how the pumps will be operated if put in."

Basically wetlands can be negatively affected by not enough water and too much water. I was constantly battling too much water in the south delta.

The wetlands here are also affected negatively by the excess water at the wrong time of year. When I was hired on Delta National Forest in 1990, we discussed the composition change and species richness reduction of the forests due to flooding. New to the area, I assumed flooding meant "flooding of the Greentree Reservoirs" for wintering duck habitat and hunting opportunities. We decided to rotate the flooding and flood every 3 years. After the winter season everything looked fine. 1/3 of the greentrees were flooded and 2/3s not. However, in March when I began to drain those that were flooded to imitate the natural drawdown, I ran into a real eye-opener, I was unable to remove the water for the growing season, because of the Little Sunflower River rising. By the End of March all the greentree levees were topped and I realized my error. The flooding was not due to my pumping the greentrees, but from the pooling of water in the south delta up against the gates. I recently asked a Forest Service employee, why they did not share this information during public hearings about the pumps. The reply was they do not get involved in Political Issues.

While working for James River, I managed the native stands of hardwoods as well as the wetlands for wildlife. During a year when the Mississippi River does not get too high and goes downs fairly early in spring, I could see how the seasonal wetlands progressed throughout the year. The water drained off ridges or outer ring of the wetland early in March leaving most of the oaks and other hard mast trees on dry ground. As April progressed, the next ring of the wetland became dry and the species tolerant to water during this time began to sprout and flourish. Then the shelf dominated by willows and cottonwood began to dry out throughout May; hence the "snowfall" of seeds early and late May. At this time the native ground cover plants get established and flourish in the muddy areas beneath these trees, In June the cypress/buttonbush areas begin to dry allowing for reestablishment of these species if necessary. Finally, in July the center of the wetland becomes a mudflat and the moist season vegetation can get established (grasses, sedges, millets and rushes). And then the wetland species take advantages of the sparse seasonal rains that fall in late summer and early fall. Basically the wetland is dry, but an abundant of seeds are produced and dropped. When the winter rains begin to fall, the seeds become available for wintering waterfowl. The dying vegetation a food source for invertebrates in the late winter and the cycle begins again. This scenario is not for all wetlands in the south delta, there are some that should dry faster and some that remain wet year round.

Recently there has been more and more excess yearly flooding and this year the wetlands I am speaking about are under about 15 feet of water and it is July. Historically, deviations occurred both flooding and drought, and these wetlands and associated habitat and wildlife survived. But recently due to the drainage project MINUS the pumps, excess flooding of these wetland has become the norm. The species cannot evolve fast enough to this man made flooding. The wetlands cannot function properly.

These wetlands I speak of are not farmland, but in forests like Delta National Forest, and other areas still wooded. These wetlands will not be harmed by the pumps but helped, with the caveat that the pumps are managed properly. And that is a big question mark, but without the pumps we know wetlands are being damaged, so let's work on making sure that the pumps are managed properly and we all can win. Perhaps we can use the pumps as leverage to have the wetlands of the north delta managed better???

Sorry so long winded. I just wrote this this morning and did not check for accuracy as to publish or share. So please do not use this as researched facts Just my observations with a lot of holes in it.

I would be happy to sit down with others to discuss this topic further and try to find a win-win solution given the present situation.

Jackie

Vmm 2pr

OPTION #2

To whom it may concern:

I am a retired Waterfowl Biologist. I spent the last 25 years of my career working in the South Delta area of Mississippi. As you know this area is actually in the northwest corner of Mississippi; not the present delta of the Mississippi River. However, it is made up of a lot of alluvial soils because of the history of the river and its tributaries in this area.

I want to tell you about my first experience in the South Delta. I graduated with my Masters in Waterfowl Management from Mississippi State University in 1990 with a thesis on the Wood Duck program at Yazoo National Refuge in the Delta. I was hired that fall by the United States Forest Service to work as a biologist on Delta National Forest which is in the heart of the South Delta. My first and foremost responsibility was to get the Green-Tree Reservoirs, part of the Yazoo Back Water Flood Control Project mitigation, ready to be pumped for wintering waterfowl. No problem! I worked with irrigation pumps, water control structures and flooding before—I got this!

Several weeks later, at a meeting with the entire Delta Staff, the field forester Ralph, mentioned to me that there was a species composition change and reduced diversity in the Forest due to the flooding, and said "check out your green-tree reservoirs". This was 1990. You have to understand Ralph; he gives you enough information for a valuable lesson or enough for you to hang yourself (I didn't know this at the time). I thought trees, especially ones here, should be able to handle winter flooding (by the way I grew up in Pennsylvania and moved to Mississippi to go to MSU from Montana/North Dakota); but, I had heard that Ralph was super smart and had been working on the Forest for a long time and knew his stuff. So I decided with about 9 GTR compartments we could flood 1/3 of them a year and that would give the forests a relief the other 2 years; hopefully providing wintering waterfowl with enough flooded water – I got this!

So choosing which GTRs to flood, I was on my way, easy-peasy! The fall and winter went well: Pumps worked, had enough water in the Sunflower River with the fall/winter rains, birds used the flooded areas, and visitors (hunters and bird watchers) to the forest were happy. Success!!!

Now, all I had to do was drain them appropriately and continue on with other projects. So, in March, I began to pull the boards that were holding water in the GTRs. I started pulling them one board at a time allowing for the water to lower slowly so invertebrates and other organisms could adjust to the lowering levels. In about a week, the Sunflower River started to rise. Maybe just a bit due to local rains, I thought. I continued pulling boards. Then the river was at the same level as my GTRs, then higher; so, I started putting boards back in. Oh yes, I had to put boards in the GTRs that were never flooded. The river kept coming up and overtopped the GTR boards and the actually levees, so now all GTRs were flooded even the ones I purposely didn't flood to help the trees. So I learned a valuable lesson, it wasn't the flooding of GTRs hurting the forests on Delta National Forest, but the rising of the Sunflower Rivers – ergo the back water flooding due to the lack of the Pumps.

So you can see, the back water flooding was degrading the forest on Delta National Forest before 1990. When I asked an employee recently why they have not been more vocal on this issue, they said they cannot comment on Political Issues. I hate that this has become a political issue. Professional working for State and Federal Agencies in the South Delta have their hands tied.

Please consider my letter, as a retired Wildlife Professional, support for the construction of the Yazoo Backwater Flood Control Pumps.

Kindest Regards

Jackie Henne-Kerr
39159 Highway 1, Rolling Fork MS
662-820-4783

OPTION #2

Vmuy 2pm

To whom it may concern:

I am a retired Waterfowl Biologist. I spent the last 25 years of my career working in the Mississippi South Delta. I would like to discuss the annual cycle of the majority of wetlands which evolved as seasonal wetlands here. Many people think a wetland is a wetland! And I have noticed this is the theme to the negative comments about this project "destroying 1000s of acres of wetlands." This is just NOT TRUE. The acres of flooding will be reduced by 1000s of acres, but these acres are not wetlands; they are roads, houses, uplands, farm fields, etc.

Most of the wetlands here in the South Delta are not permanent, but seasonal wetlands. Historically they fill during winter rains, and are dry by July. The periodic spring flooding of the Mississippi River in past centuries did not have a significant impact on the evolution of these wetlands. If the River did overtop is banks, the flood waters rose over the already full wetlands and the ridges for several days in early spring than drained out. I want to summarize what the seasonal or monthly changes to these wetlands should be, without the prolong manmade flooding of recent decades; and how vegetation and waterfowl adapted to this natural rhythm.

This is a simplification, but I want to describe the seasonal progression of a wetland I managed focusing on ducks. The wetland is like a soup bowl; it has a slope from the edge or ridge, this slope goes down to a step or flat (where the parsley or other herb is sprinkled in a fancy soup bowl), then there is another slope to the bottom of the wetland or bowl (where the soup is). The difference between the wetland and the soup bowl is that the wetland has ridges in the bottom, most less than a foot high, but significant none the less (plus it is not round, but elongated because it is an old oxbow). So let me list the changes that should occur to the water and vegetation in my wetland as the year progresses.

- Starting in early spring: this seasonal wetland is full from the winter rains. If the river floods, it leaves quickly allowing the upland vegetation on the ridges around the soup bowl to begin to sprout, germinate, and leaf-out in

February and early March. The ridges have an overstory of red oaks, elms, sweetgum, pecan, and hickories; maples, mulberry, pawpaw and winged elm are in the understory. Ground cover species bloom quickly before the overstory steals all the sunlight; cane, vines and briers patches abound. My wetland is still full of water.

- March comes and goes, water in the wetland soak into the ground and begins to evaporate due to the warmer, sunny weather. The upper slope of the soup bowl begins to emerge as the water goes down. There is a new flush of green; a different type of trees, shrubs and herbaceous vegetation grow on this upper slope due to when the soil emerging from the water. Ridge species begin to fade out and later flushing nuttall, water and willow oaks, hackberry and persimmon are in this area and begin to green up.
- During April again evaporation and infiltration lowers the water in my wetland. The bottom of the upper slope is now greening up; and another ring of desirable vegetation will flourish.
- In May we have "snow storms" of willow and cottonwood seed floating on the winds trying to find a place to land and germinate. With the water levels dropping and the step becoming a mudflat, it is perfect timing for these trees to get started! If there are already cottonwood and willows established, the ground vegetation of smartweed and other wetland species flush out. Willow tree leaves are thin and drooping and cottonwood leaf petioles are flattened so the leaves hang down also, allowing for sunlight to reach the forest floor.
- As June progresses, the lower slopes of my wetland are now drying out. On this slope and on the ridges in the bottoms cypress grow. Buttonbush thickets form at the base of the cypress and on the ridges in the bottom of the wetland. These species can tolerate a lot of water, but not if it overtops the tips of the plants and stay too long into to July when the water will be so hot that it actually scalds the young trees and shrubs. Sedges and rushes also take hold in these areas when the water leaves at the right time.
- And then July comes; and it is hot and dry. The bottom of the slough is now a mud flat; grasses, millets and other warm season vegetation begin to grow. They have to grow fast, the bottom dries so quickly that they don't have much time before the moisture is gone. Woody vegetation doesn't grow in the bottoms normally, the season and moisture dictate what grows

here. By the end of July, the plants we call warm season grasses or moist soil plants have mature and will produce a layer of seeds sometimes inches thick in these bottoms. This seed bank is so important for the wildlife especially waterfowl and it NEEDS to be here in the bottom.

- Now it is August, the bottom of the slough begins to crack the moisture goes deeper and deeper into the ground. Cracks as wide as 6 inches and several feet deep are present throughout the bottom of my wetland. Nothing is growing, but the feast is laid in preparation for winter.
- September bring early fall rains. The cracks begin to close as the moisture gets closer and closer to the surface of the slough bottom. All other levels of the slough; bottom ridges, lower slope, the step and upper slope and ridges have vegetation maturing and getting ready for winter. Blue-wing teal pass through but this seasonal wetland is not ready for them, there is no pooling water.
- October/November brings other migrating waterfowl (mallards, wigeons, gadwalls and more) to the Delta. And water is beginning to pool in the bottom of my wetland. All those seeds are there for them to feast on and recuperate from their migration.
- December and more rain. Now the water in the slough bottom is too deep for dabbling ducks to get the seed; but that's ok in a normal year they probably already ate most of it and now the water depth on the ridges and lower slope is just right for them to get button bush and other seeds dropped there.
- January rains raise the water into the willow/cottonwood flats. In normal years the ground vegetation there is very leafy and it and the willow and cottonwood leaves and branches are perfect for aquatic insects to live. Waterfowl at this time are preparing for molt, migration, and egg production. The birds need these insect larvae for the required nutrients. Ducks are also beginning to make pair bonds, the water around the buttonbush branches and the willow and cottonwood trunks are necessary for seclusion.
- Its February again, water is now near the top of my slough, ducks are utilizing seeds and acorns in this area as they migrate out to their summer nesting grounds. The cycle ends and a new one can begin.

But what happens to my slough when flooding occurs like it did in 2019 and 2020. Water remained high in the slough, actually over the slough and the surrounding ridges. Vegetation did not flush when is should have because the water did not retreat it a timely fashion. Cottonwood and willow seeds never landed on mudflats, so they didn't germinate and were not available for wildlife to eat and nest in. briers did not grow, cane was under water and did not sprout, no vegetation grew in the bottom of the slough. Most animals died or at least were not able to nest and/or reproduce. When the slough did start to dry out in late July, no vegetation grew under the willow/cottonwoods it was too late in the season. Some vegetation like cock-a-bur did grow in August, but it is not a desirable or sustainable species for wintering waterfowl. As winter comes the birds will come, but there will be no food in my slough and they will leave. They will have to compete with other waterfowl in areas they are not familiar with and they might not survive. This excessive flooding is not something the vegetation and wildlife in the South delta can withstand yearly. Please realize this paragraph describes not only my wetland during 2019 and 2020. It is the scenario of all seasonal wetlands in the backwater flood area of the Mississippi Delta when we have water like we did in 2019 and 2020.

When I talk to others that have lived here in the South Delta longer than I have, I notice that these severe flooding events are happening more often and for a longer period of time. This, I am sure, can be attributed to more and more modifications of the Mississippi River watershed up river and to climate conditions changing causing more local rains in and around the Yazoo Backwater Area. These conditions are not going to go away. The wildlife and wetlands in this area need the pumps as much or more so than the residents and farmers. The pumps will be a win, win, situation for people and the natural resources in the South Delta. Please, build and utilize the pumps!

Thanks so much for listening,

Jackie Kerr,
Retired Waterfowl Biologist
12315 Highway 1
Rolling Fork, MS 39159
662-820-4783

OPTION #2

Taken from article written by PATRICK DURKIN May 11, 2020

Turkeys starved in treetops. Ravenous raccoons killed nesting turtles and newborn fawns. Countless other wild animals perished during a record 219-day flood last year in Mississippi's Yazoo Backwater Project.

The Yazoo Backwater's surrounding levees provided the only high ground for displaced wildlife, but all those miles of manmade barriers provided little sanctuary throughout the unprecedented deluge. The Backwater, or South Delta, covers about 1,550 square miles of fertile valley in west-central Mississippi north of Vicksburg, where the Yazoo River flows into the Mississippi River.

The Yazoo Backwater reached flood stage (87 feet) on Jan. 4, 2019, peaked at a record 98.2 feet on May 23, and stayed above flood stage until Aug. 10. The flood's crest coincided with the region's peak nesting and fawning periods, crushing populations of wild turkeys, whitetail deer, and ground-nesting birds.

The Backwater's floods also drowned two people, covered three highways, and swamped or destroyed 686 residences. The seven-month flood caused at least $800 million in agricultural losses and damage across half a million acres of farm fields.

When the stagnant waters finally receded in late summer, residents and business owners returned to homes and buildings fouled by sewage, garbage, agricultural chemicals, snakes, and rotting animal carcasses. Unfortunately, sustained rain and prolonged flooding returned this year, furthering the losses of homes, property, croplands, and wildlife.

Devastated Wildlife

William McKinley, deer program coordinator for the Mississippi Department of Wildlife, Fisheries, and Parks, said the Backwater's 2019 fawn "crop" was devastated. So was the entire turkey population. Agency biologists and researchers at nearby Mississippi State University documented only four turkeys in 8,790 wildlife photos taken in October 2019 during a month long post-flood study using 300 trail-cameras. That study on the Shipland Wildlife

Management Area, one of seven WMAs that flooded, also estimated a 5% fawn survival rate.

The biologists conducted weekly deer surveys along a 26-mile route on the Backwater's southwestern levees. They regularly photographed emaciated deer and counted 503 dead whitetails from mid-June to early August. They necropsied deer when possible, and attributed most deaths to starvation and heat exposure. And because this is where Mississippi first detected chronic wasting disease in February 2018, they also collected tissue samples for CWD tests.

Much of the devastation occurred on levees flanking the Yazoo Backwater's western border with the Mississippi River and its eastern border with the Yazoo River. If this were an animal horror movie, warning signs on the levees would read, "Abandon hope all ye who enter here." Everything that could fly, walk, crawl, or slither sought refuge on the containment walls. Once there, they fought for food, shelter, and shade—all of which were scarce.

McKinley said starving raccoons proved a nuisance and nemesis to all. They honeycombed the levees by digging burrows for shelter, making it difficult for agency and university biologists to walk without stepping into holes.

"I figured the raccoons would live up in the trees, but they settled into holes all across the levees and stayed," McKinley said. "You had to be careful where you stepped. Every 25 yards you'd find a hole with a raccoon in it. We have no idea how many were out there, but they were dying, too. They were in poor condition; unkempt and unaware, and in really poor health. When they were scavenging something, we'd get within 4 to 5 feet before they realized we were there."

Turtle Carnage

When the biologists weren't dodging raccoons and their burrows, they were driving or stepping around their means to survival.

"Empty turtle shells from red-eared sliders were everywhere," McKinley said. "There were thousands of them. One time we saw three raccoons tussling over a big red-eared slider. All the female turtles were on the levees. They had nowhere else to lay their eggs. The raccoons figured them out quickly. They chewed off a rear leg, reached up inside for the eggs, cleaned everything out, and moved on to the next one. They picked them clean. Those turtle shells looked like they'd been steam-washed."

McKinley thinks raccoons also killed newborn fawns soon after birth. Every pocket of shade held animals, so pregnant does couldn't seclude themselves when fawning.

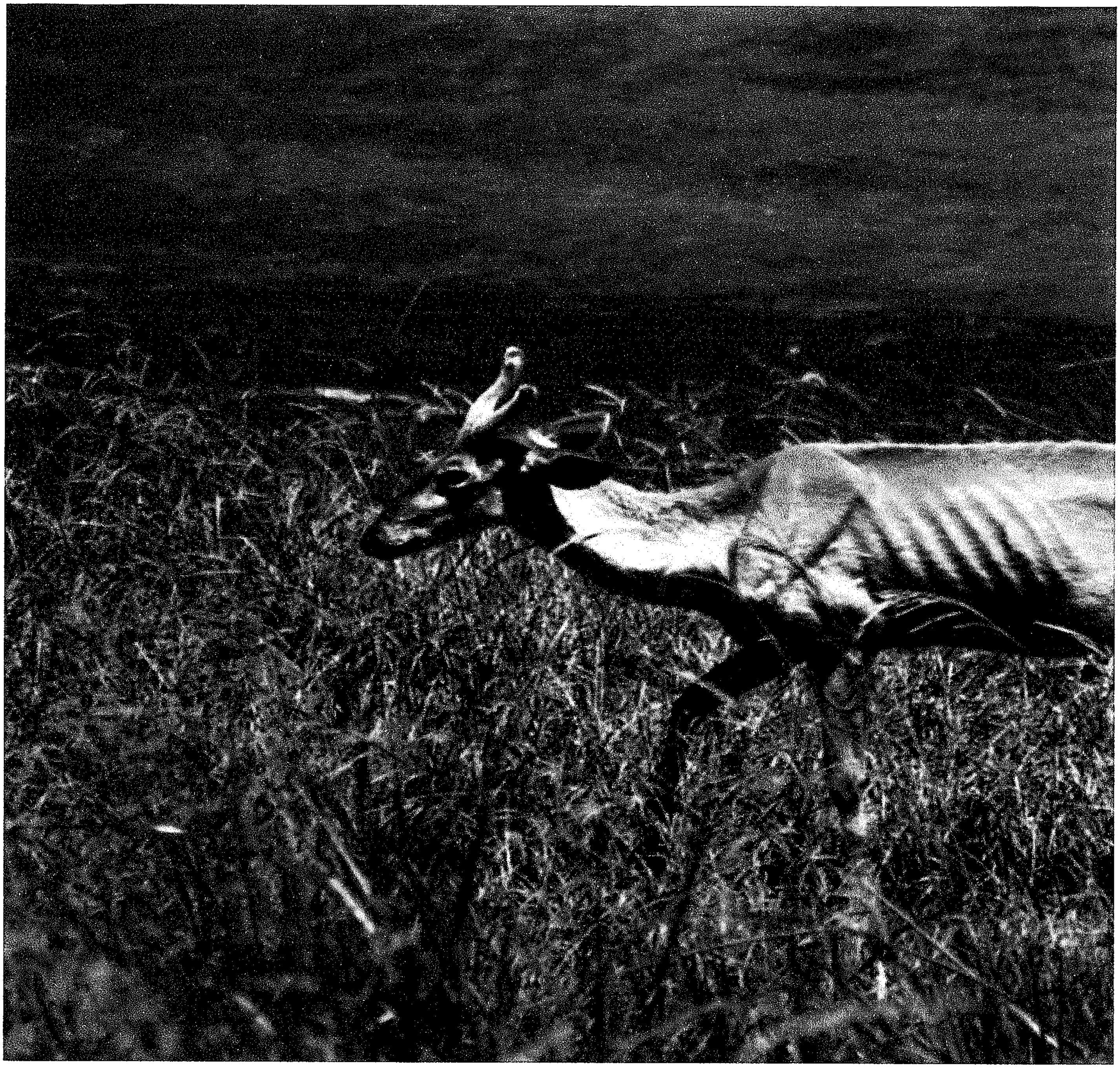
"I can't document it, but it looked like the raccoons just gathered around the does and waited for fawns to drop," McKinley said. "I firmly believe that. The only broken bones were the fawns' ribs, so I doubt something bigger killed them and that the raccoons just cleaned things up. All the bigger bones were chewed, not broken. All the meat was picked clean."

McKinley said those scenes were among the flood's many unexpected sights and behaviors. During most floods elsewhere, deer flee lowlands for the nearest hills and higher ground. Some deer from the Yazoo Backwater probably did, too, but many did not. Those remaining spent so much time in water that their hooves grew soft with rot. McKinley also recalled counting 1,200 deer scouring a field in 12 inches of standing water on a hot day, three hours before dark.

"We can't explain why so many deer stayed," McKinley said. "They have ways to get out, but it's not easy. On the other hand, assuming some deer fled, if they had CWD they carried it to new areas. We have lots of questions that will take a while to answer."

McKinley said most songbirds also fled the Backwater, but there was no escaping the stench of death and unique, unexplained oddities. Paper wasps, for instance, usually build their papier-mâché nests just off the ground in low brush. But with floodwaters covering brush and reaching far up trees and powerline poles, the wasps built their volleyball-size nests on the powerline's thick wires.

"We'd be driving along and see a wasp nest on a wire, and wonder why would they build there with trees everywhere," McKinley mused. "But then we'd see another nest, and another and another up on the wires."



Turkey Struggles

The Yazoo Backwater's wild turkeys, however, left scant evidence of their presence or passing. Adam Butler, wild turkey program coordinator for the Mississippi DWFP, said the area's turkey flocks had already declined much of the past decade because of frequent flooding, but brood surveys in 2018 suggested a considerable boost for the population.

Unfortunately, last year's flood made poult production impossible, and Butler worries the flock lost the previous year's gains, and maybe more. He said turkeys can't live and forage for long in treetops, and can't find food closer to the ground during floods. That's not just Butler's opinion. He references research by Michael Chamberlain, a recent guest on the MeatEater Podcast (Episode 214), who documented only one in five adult turkeys he monitored in 2011 survived a month-plus flood farther south in the Atchafalaya Basin.

Chamberlain noted that turkeys move to higher ground if they know it exists. But if that ground isn't high enough to escape floodwaters, turkeys just keep searching their known turf until starving to death. At least that's what Chamberlain's GPS-collared turkeys showed.

Here's how that went: A bobcat killed one hen the day the flood began. Another hen lived 21 days, and a third disappeared. It's unknown if the missing hen's collar malfunctioned or got destroyed in the flood. The lone surviving hen found dry ground 29 days into the flood as waters receded. The lone tom should have stuck with her. It died in a water-inundated area 31 days into the flood.

"Turkeys aren't like deer," Butler said. "Turkeys typically stay near home. They don't know the land beyond the horizon."

Butler said the Yazoo Backwater's turkey flock typically isn't large, and usually cycles with regional flooding. The hatch booms to bolster the flock in years with short flood seasons, and busts in years with heavy flooding. Adults typically endure because most floods recede after two to three weeks. Insects and vegetation pop up soon after, and life goes on.

Watery Trend

That pattern fell apart the past decade because of prolonged rains and flooding. "Adult turkeys can't survive in the trees' canopy six to seven months like we saw last year," Butler said. "We expect their survival in the Backwater last year was very low. It's possible the survivors might pull off a hatch this year, but it's getting late [April 29] and the river is still at flood stage."

The 2019 flood and its harm to people, property and wildlife aggravates a long festering debate in the Yazoo Backwater and extended Mississippi Delta system, which spans 200 miles from Vicksburg to Memphis, Tennessee.

Levees on the valley's entire western edge protect it from the Mississippi River's floodwaters, and levees on its southeastern side protect it from the Yazoo River's floods. The land mass in between covers nearly 4,100 square miles, slightly smaller than Connecticut.

And here's the scary part: All water and waterways within the leveed valley have only one way out: a "bathtub stopper" called the Steele Bayou Structure upstream from the Mississippi River. When the Mississippi floods, the Army Corps of Engineers shuts the Steele Bayou control gates to prevent floodwaters from backfilling the Yazoo Backwater and larger Delta.

That's no small task. By the time the Mississippi River reaches Vicksburg, it's carrying 41% of the continent's runoff, which includes its own watershed starting in Minnesota; the Missouri River's watershed starting in Montana; and the Ohio River's watershed starting in Pennsylvania.

When a swollen Mississippi River forces Steele Bayou's floodgates to shut, residents pray that winter and spring rains stay away. If they don't, the Yazoo Backwater starts filling. Everything will be fine if the Mississippi River recedes before the Backwater reaches flood stage. If not, the 2019 scenario unfolds. (That buildup began in October 2018 with sustained heavy rains.)

The Backwater's original engineers considered such emergencies: They would build a giant pumping station at Steele Bayou once the structure was finished (1969). To prevent disasters like 2019, those pumps would evacuate rainfall trapped within the levees.

But the pumping station was never built. Funding squabbles between state and federal officials delayed construction for decades, and then the Environmental Protection Agency ruled against the pumps in 2008. Regional rainfalls since then have caused simultaneous flooding inside and outside the Backwater several times.

Conclusion

Meanwhile, hunting clubs, conservation organizations, and the Mississippi DWFP spent much of the 1980s and 1990s using the Conservation Reserve Program and Wetland Reserve Program to help improve the Delta area's turkey habitat. Butler hopes all that money and foresight wasn't in vain.

“A lot of those trees are now 25 years old, and turkeys can probably start using those areas over the next five years,” he said. “We’d like to get back to doing some trap-and-release to help re-establish those flocks. It would make a great turkey woods if we give it the needed time. That would be a real success story.”

Vmmy 2pm

OPTION #2

Edward E. Belk, Jr
Director of Programs
Mississippi Valley Division
US Army Corps of Engineers
Vicksburg District
ATTN: CEMVK-PPMD
4155 East Clay Street
Room 248
Vicksburg, MS 39183

Dear Sir:

I know the COE has been working in the South Delta for years and are asked again and again to do another study. I feel this request is just a way to postpone the completion of the Yazoo Backwater Project (Pumps) project. Or it is a fishing expedition from those against the pumps hoping to find evidence that the pumps are harmful. It is my understanding all the studies to date have not found that the Pumps will be harmful to the environment in this area.

I just want to emphasize the organizations and professionals that like you work in this area that are supportive of the pumps and some organizations that are supporting the pumps from afar.

Mississippi Department of Wildlife Fisheries and Parks voted in June 2019 to support the pumps because of the negative impacts on wildlife populations.

Nature Conservancy in Mississippi letter of August 2019 noting flooding imposes a tremendous burden on the natural resources.

Mississippi Forestry Commission pass a resolution in support of the Pumps March 10,2020 "adverse impacts on natural habitat, wildlife, and trees."

The Mississippi Wildlife Federation changed their position from against the pumps in their letter of intent to sue earlier this year.

Although I haven't found any documentation from the USFS against the pumps talking to past employees they have talked about the devastation that is being done on Delta National Forest. I personally worked on the DNF as a biologist in 1990 and was told by a forester that "the flooding was causing species composition change and reduction of species diversity". As the waterfowl specialist there I saw the negative impacts while trying to manage for wintering waterfowl.

Employees of the local USFWS have mentioned big trees falling due to the soil being waterlogged in the summer.) this is evident in most wooded areas in the South Delta after the 2020 flooding.

As a biologist for a timber company and working in the South Delta I can attest to the damage to the trees and wildlife in the area.

The Audubon Society as far as I know has not changed their position against the pumps, but their article against the pumps is not as prominently displayed. I had read several comments about the areas from retired professionals in the South Delta showing that the article has several inaccurate statements in it. I wonder when they say the pumps will drain 200,000 acres of wetlands and other sources are saying 200,000 acres of farmland are flooded. Are they the same acres? If the 200,000 acres of farmland is flooded, then the acres of actual wetlands are flooded also. And too much water in a wetland during the summer month is as more detrimental than not enough. I also just realized that Audubon Society does not have an office in Vicksburg anymore.

I have talked to foresters, biologists, conservation officers, land managers that have worked or are still working in the South Delta Area. We are all in agreement the pumps will help wildlife and habitat.

Please do your best to convince the EPA that the Pumps will be alleviating man made flooding and will help the communities and wildlife in the Delta.

Kindest Regards,

Jackie Kerr; Retired Biologist/Forest Manager
James River/Tembec, Fitler MS
Present Personal information: 12315 Highway 1, Rolling Fork MS. 662-820-4783

OPTION #2 Vmmy 2pm

My name is Jackie Kerr and I am a retired waterfowl biologist and forest manager and I worked in the South Delta for about 20 years since 1990.

Points I would like to make to rebut some other statements.

1. "The pumps will not ONLY help the rich white farmers."
    a. The farmers (rich white, poor white, rich black, poor black) have insurance so when there are flood years like 2019 and 2020; it breaks their heart more than their bank.
    b. It is the community and residents that depend on the farmers that loose most of all.
        i. The restaurants that depend on the farmers feeding their planting and harvest crews will not have business if there is no planting or harvesting.
        ii. The seed, chemical, fertilizer, equipment, parts stores, those businesses that are in the south delta because of agriculture, will have no business if there is no farming for the year.
        iii. The laborers whether farm or other business will not be able to work if there is no agriculture for the year.
        iv. Other private businesses like independent truckers, electricians, lumber companies, daycares, barbers, you name it are in business because of the agriculture holds residents in the area and these businesses can survive.

    So, in actuality, everyone else will benefit more from the pumps than rich white farmer.

2. "Building the pumps will NOT destroy 300,000 acres of wetlands in the South Delta." Like mentioned in one article.
    a. There are only 290,000 acres of wetlands in the south delta – do I need to say more about that statement? Creative Marketing, maybe????
    b. The project is all but completed; the infrastructure - ditching, levees, gates, weirs, etc, is done. The only thing left to do is putting in the actual pumping station in, and this final proposal is to put the pumps where they were originally planned, and it is my understand that the pad dirt work is already completed.

    So, point blank, this information is not truthful. Unfortunately, the organization making this statement and other organizations against the pump stating the pump will be detrimental to wildlife and wetlands do not have active programs or people on site in the South Delta. Enough said!

1. As biologist, forest manager and conservationist working and living in the South Delta over the past 30 years, I am for the completion of the Yazoo Backwater Pumps Project by taking the final step and installing the pumps. I was excited to see the addition of wells placed in the north delta to maintain the aquatic streams and bayous that tend to

dry up in the summer. Living and working here in the South Delta has open my eyes to the uniqueness of the area and how the uncompleted Yazoo Back Water Pumps Project has affected it.

a. First let me describe some the wetlands in the South Delta; a significant number of wetlands are seasonal. They are like soup bowls spread out on a table. Between the soup bowls are the "ridges" there are also ridges along the creeks, rivers, and bayous; with one side usually, a high ridge while the other side is sloping due to river movement. Then also between significant creeks and rivers there are flat ridges where the farmland is now located as well as the towns. This is where the "Mound Builders" also had their communities and farmlands. And it hard to believe but there were a lot more people in these historical cultures living in the Delta than people live there now. The rainy season in the Delta is in the winter early spring. These rains fill up these seasonal wetlands, Not the Mississippi River! Similarly, to the seasonal wetlands, the shallow and deep aquafers are not replenished by the River.
b. The River built and shaped the Delta over millions of years. River flooding to the height of the 1927 and 2011 floods are labeled the 500-year flood. These levels have a 1/500th chance of happening each year. So, statistic says they can happen back to back or never. Some people think of these happening every 500 years. Then there are the 100 year floods and the 50 year floods that happen more frequently. BUT to have 2 500, 12 100 and over 20 50-year floods in a 100-year period didn't happen historically. So why now? MAN. It is not just happening in the Mississippi Delta or the areas that have similar back water projects on both sides of the river, but up stream. Think about how many thousands of acres of the Mississippi Watershed is paved over, has houses on, is ditched and has vegetation modifications. All this sends more water down the River to the gulf. With projects like this all we can do is try to mimic nature as best as we can to maintain the vegetation and wildlife that adapted to the historical conditions. The changes we made to the area in the last 200 years are happening to fast for the plants and animals to adapt.
c. So, what is the pooling of the yazoo backwater flood water doing to the wetlands and wildlife. Remember the over-the-bank flooding of the Mississippi River historically was due to snow melt from up stream. This happened in Feb/March. The river came up flooded out at different levels depending on the year into the floodplain and then receded quickly depending on the height 10 to 20 days. The river depth and width were able to contain other runoff throughout the rest of the year. No levees holding and gates and ditching holding and directing the water. The plants and animals adapted and flourished in these historical conditions. The trees even the cypress are deciduous; an adaptation to the winter storms when standing in water (less likely to windthrow with out leaves). They were dormant during the winter allowing the standing water in the winter

to not affect their growth and health. The water left from the tree roots prior to leaf out. Thus, allowing for growth and root health. Some trees adapted (like willow and cottonwood) to leafing and seeding out later and are able to be at lower elevations in the wetlands with out being stresses. Cypress and Tupelo Gum are even later and have extra adaptations to deal with standing water later in the spring.

Vhmm 2pm

Hi, Jackie Kerr retired waterfowl, biologist.

I was told I couldn't talk as long today as I did last time I was here, so I thought I better write down what I want to say. And that is just thank you. You were asked to find a solution to this problem with a new set of eyes and ears — that's like a judge telling the jury to disregard that last statement. Is that possible? Obviously so because you did it. You disregarded what was said on either side for the past 20 years, you disregarded politics, you looked at what was being said not who said it nor how many times something was repeated, you looked at the research, not the conclusions others drew from it. You used your compassion, knowledge and experience and came up with a plausible solution for everything and everyone.

We are indebted to you and I hate to ask you for more: but I'm am. When you get back to the hill, please do everything in your power to get this project with no strings attached initiated right away, the construction started and completed as soon as possible. I for one am looking forward to seeing the south Delta, Delta National Forest, and other wetlands habitats on the right path back to being what they should be. And if there's anything we can do to expedite this, please let us know. Again, Thank you, THANK YOU, Thank you.

OPTION #2

OPTION #2

Hi, Jackie Kerr. First, I want to say thank you for your time and effort you put into this extremely important issue to the South Delta.

Please count me as one who supports the Yazoo Backwater Pumps Option #2. I worked as a Waterfowl Biologist and Forest Manager in the South Delta for nearly 20 years. I want to speak for the wetland ecosystems in this area. The wetlands need a pump and option # 2 will serve them best.

As a biologist it didn't take but 3 months on Delta National Forest to become painfully aware of the issues with the Backwater flooding when I started working in 1990. It is very hard to manage wildlife habitat when it is flooded during the **growing season**. Even though this area was always influenced by water; first as a delta and then as a floodplain, THIS FLOODING IS DIFFERENT, IT IS MANMADE. The soil, flora and fauna evolved with winter flooding; not high water during the growing season. This MAN-MADE FLOODING during the summer is causing specie shift and diversity reduction and lack of plant growth and seed production so important for the bottomland hardwood ecosystems and especially wintering waterfowl.

I participated in a butterfly count on the forest last week. It was easy to see forest is being degraded due to this flooding. Someone new to the area could say what a beautiful forest and I would say you should have seen it in the 1990, But when I was there in the 90s, people said you should have seen it in the 40s and 50s. The effect of the 2019 and 2020 back to back summer flooding is obvious. There are so many dead standing and fallen trees. This is not the way a bottomland hardwood forest should look. It is not a healthy ecosystem.

Scientists have documented this decline. Look at pond berry colonies. Way down from 1990 to 2022. To halt and reverse this decline we need the pumps, removing the excess flood water in March. Look at forest health from the 1950 to now. Look across the river and at other backwater projects that have pumps – all is well including the forests and wetlands. I ask you to please be careful when considering opinions of folks from other areas of this state and country. Be careful of those who are using this situation as a fund raiser for their organization. Even as professionals we tend to skew our thoughts based on our experiences where we live and work. I came from North Dakota and if you had told me there can be too much water in a wetland, I would have said you were lying. A friend of mine, very intelligent, is against the pumps because she says farmers pumping out of the shallow aquafer near her home south of Greenville caused their hand dug well to go dry. She could be right, but that is totally different pump situation. We have to believe in the science here.

Some say let nature take its course. I do believe mother nature knows best. But when man has modified a watershed as large as the Mississippi River's to the extent we have, our only recourse is to try to imitate mother nature in small areas like the south delta. By removing the excess water caused by man, we can let mother nature take it from there. Remember the wetlands especially seasonal ones which much of them are in the Delta get filled by winter rain, not river flooding. And the annual cycle of these wetlands -- they are full in March and began to dry down through evaporation and percolation till the center is a mud flat in July. **Each stage** of the water level produces different vegetation communities in rings around the wetland. The moist soil plants will grow and be a buffet for the wintering waterfowl as the fall and winter rains begin to fill them up. Then in March the annual cycle begins again ---IF and ONLY IF the pump will remove the excess flood water WHEN NEEDED.

Thank you for your time and effort to understand this complicated issue. And please push for option #2 which on the ground science has proven to be the best option for the bottomland hardwood ecosystems and wetlands we have here.

Jackie Kerr
Retired Waterfowl Biologist and resident of the South Delta
12315 Highway 1 Rolling Fork MS 39159
662-820-4783

Vicksburg 6pm

COMMENT CARD

Yazoo Backwater Area Water Management
DEIS Public Meeting

* Please note all fields are optional.

Name: Stan Thibodeaux

Phone: 225-573-1830

Address: 298 Caravane Circle Vicksburg MS. 39183

Email: Sthib7807@gmail.com

AREAS OF CONCERN

* Check all that apply.

- [x] Home Accessibility
- [x] Housing or Property Impact
- [x] Access to Emergency Services
- [x] Impacts to Wildlife
- [x] Impacts the wetlands/environment
- [x] Infrastructure (Electricity or Road Accessibility)
- [x] Agriculture (Flooding of Farmland or Loss of Livestock)
- [x] Hunting or Outdoor Recreation
- [ ] Other: Adding danger to Kids on school buses traveling Levee w/water on each side

COMMENTS, QUESTIONS OR SUGGESTIONS:

You cannot Finish Something until it has started. So lets START the pumps so one day they will be finished.

Vmmy lypm

COMMENT CARD

Yazoo Backwater Area Water Management
DEIS Public Meeting

* Please note all fields are optional.

Name: Paige Adcock

Phone: 662-571-7128

Address: 559 Boyd Road
Holly Bluff, MS 39088

Email: cpapaige@gmail.com

AREAS OF CONCERN

* Check all that apply.

- [x] Home Accessibility
- [x] Housing or Property Impact
- [x] Access to Emergency Services
- [x] Impacts to Wildlife
- [x] Impacts the wetlands/environment
- [x] Infrastructure (Electricity or Road Accessibility)
- [x] Agriculture (Flooding of Farmland or Loss of Livestock)
- [x] Hunting or Outdoor Recreation
- [ ] Other: ____________________

COMMENTS, QUESTIONS OR SUGGESTIONS:

I am voting for Alternative 2. Thanks for all of your co-ordinated efforts. The South Delta is grateful... and finally, hopeful.

Vmug Lynn

COMMENT CARD

Yazoo Backwater Area Water Management DEIS Public Meeting

* Please note all fields are optional.

Name: Austin Willis

Phone:

Address:

Email:

AREAS OF CONCERN

* Check all that apply.

- [x] Home Accessibility
- [x] Housing or Property Impact
- [x] Access to Emergency Services
- [x] Impacts to Wildlife
- [x] Impacts the wetlands/environment
- [x] Infrastructure (Electricity or Road Accessibility)
- [x] Agriculture (Flooding of Farmland or Loss of Livestock)
- [x] Hunting or Outdoor Recreation
- [x] Other: ______

COMMENTS, QUESTIONS OR SUGGESTIONS:

Vbrg 10am

COMMENT CARD

Yazoo Backwater Area Water Management
DEIS Public Meeting

* Please note all fields are optional.

Name: EARL WALLACE

Phone: 601-831-3260

Address: 1858 LAKESIDE DR V/Brg 39180

Email: Wallace.earl@15 Gmail.com

AREAS OF CONCERN

* Check all that apply.

- [x] Home Accessibility
- [x] Housing or Property Impact
- [x] Access to Emergency Services
- [x] Impacts to Wildlife
- [x] Impacts the wetlands/environment
- [x] Infrastructure (Electricity or Road Accessibility)
- [x] Agriculture (Flooding of Farmland or Loss of Livestock)
- [x] Hunting or Outdoor Recreation
- [ ] Other: ______

COMMENTS, QUESTIONS OR SUGGESTIONS:

Vmurg loan

COMMENT CARD

Yazoo Backwater Area Water Management DEIS Public Meeting

* Please note all fields are optional.

Name: Jeff Terry

Phone: 601-334-0690

Address: 16124 Hwy 465 Vickburg MS 39182

Email: jeff.terry50@yahoo.com

AREAS OF CONCERN

* Check all that apply.

- [ ] Home Accessibility
- [ ] Housing or Property Impact
- [x] Access to Emergency Services
- [x] Impacts to Wildlife
- [ ] Impacts the wetlands/environment
- [ ] Infrastructure (Electricity or Road Accessibility)
- [x] Agriculture (Flooding of Farmland or Loss of Livestock)
- [x] Hunting or Outdoor Recreation
- [ ] Other: ______

COMMENTS, QUESTIONS OR SUGGESTIONS:

Admennent #2

Finish the pumps

Vhuing loan

COMMENT CARD

Yazoo Backwater Area Water Management DEIS Public Meeting

* Please note all fields are optional.

Name: Richard Pearce

Phone: 601-529-2179

Address: 16629 Hwy 465, Vicksburg, Ms

Email: rickpearce@ftcweb.net

AREAS OF CONCERN

* Check all that apply.

- [x] Home Accessibility
- [x] Housing or Property Impact
- [x] Access to Emergency Services
- [x] Impacts to Wildlife
- [ ] Impacts the wetlands/environment
- [x] Infrastructure (Electricity or Road Accessibility)
- [ ] Agriculture (Flooding of Farmland or Loss of Livestock)
- [ ] Hunting or Outdoor Recreation
- [ ] Other: ______

COMMENTS, QUESTIONS OR SUGGESTIONS:

Support Alternative #2

Vicksburg 10am

COMMENT CARD

Yazoo Backwater Area Water Management DEIS Public Meeting

* Please note all fields are optional.

Name: Anna Jones

Phone: 601-278-4494

Address: 474 Lewis Rd. Rolling Fork, MS 39159

Email: annamjones324@gmail.com

AREAS OF CONCERN

* Check all that apply.

- [x] Home Accessibility
- [x] Housing or Property Impact
- [x] Access to Emergency Services
- [x] Impacts to Wildlife
- [x] Impacts the wetlands/environment
- [x] Infrastructure (Electricity or Road Accessibility)
- [x] Agriculture (Flooding of Farmland or Loss of Livestock)
- [x] Hunting or Outdoor Recreation
- [ ] Other: ____________________

COMMENTS, QUESTIONS OR SUGGESTIONS:

Proposal #2: Please help us finish the pumps. We're tired and we need a sense of relief and safety. I'm ready to move back into my home and finally live comfortable and peaceful.

David Wansley
120 Brookwood Dr.
Vicksburg, MS 39183-8101

July 23, 2024

Attn: CEMVK-PPMD
Vicksburg District, U.S. Army Corps of Engineers
4155 East Clay Street
Vicksburg, MS 39183

To Programs-and-Project-Management:

I was reared on a family farm off the old dummy-line road in Sharkey County. My dad cleared up a parcel of land approximately 1,640 acres starting in 1965 until we moved there in 1967. I still farm in Warren and Issaquena County. I am a second-generation advocate for the pumps and most thankful that all three agencies are working together so perhaps my son who is forty-two years old will not have to wait as long as I am waiting for the pumps!

I have attended many meetings as well as the one last night July 23, 2024, at the city auditorium. I had several thoughts after talking with my friend Peter Nimrod but frankly I am worn down and tired of trying to explain why we desperately need the pumps. I was surprised by the low turnout of residents, employees, farmers and landowners but I can certainly relate to the repetitious comments year after year.

I would be in favor of the second proposal and hope there could be some adjustments to the water levels and stop/start dates. I farm corn, cotton and soybeans from Valley Park down to the canal and some years we are really late getting cotton out of the fields.

This is just for information but our farm employees have asked to be put on guaranteed forty-hour week or a bi-weekly salary to make sure their family has income during extended backwater events. We started doing just that over a year ago!

Thank all of you for your time and effort as this project moves forward.

Respectfully,

Valley Park
Elevator, Inc.

July 24, 2024

Attn: CEMVIK-PPMD
Vicksburg, District, U.S. Army Corps of Eng.
4155 East Clay St.
Vicksburg, MS 39183

Re: DEIS Public Meeting Yazoo Backwater Area Pumps

To Whom It May Concern:

I am writing on behalf of a farmer cooperative located in Issaquena County just south of Valley Park. We have at present fifty-four active members and a customer base from Eagle Lake, Mayersville, Rolling Fork, Anguilla and Cary. I know there are a lot of areas in-between. Our cooperative delivers corn into the poultry industry in Mississippi and we truck soybeans to our barge loading facility on the Harbor in Vicksburg. My point being most of us farm and have employees and residents in the backwater area. We are and have been supporting the installation of Yazoo Backwater Pumps for years. We are basically a second-generation business that was started in 1967. Most of us grew up as the canal was being dug and seeing the gates finished in 1975 without the pumps installed. We have also been the recipients of many years of man-made flooding.

We are excited to finally see the three governmental agencies coming together to perhaps "Finish the Pumps". Unlike surrounding states and the Northern Delta, we have the unfortunate risk of never knowing when or the extent of another flood. It is beneficial most years to plant early, however, in our area we have the unfortunate risk of not knowing when it is going to flood, the elevation it will flood and how long the gates will be closed as we wait for the stopper to be pulled like a bathtub drain. We are anticipating the pumps as well as alleviating some portion of that risk. Since 2019 we have seen soil erosion, drainage problems and the never-ending burden of trees dying and littering roads, power lines and fields.

We, as a group, support proposal two and welcome a discussion that modifies your water levels as well as the dates turning the pumps on and off.

We very much appreciate all the time and effort the agencies have put into this project. Please let us know if we could be of help in any way.

Sincerely,

David Johnson
President

Post Office Box 188 . 2900 Hwy 61 . Valley Park, MS 39177-0188 . Phone 601-638-3481

/

Jim Steitz
5330A Jamieson Avenue
St. Louis, MO 63109

August 2, 2024

RE: Withdraw Yazoo Area Pumps Project

ATTN: CEMVK-PPMD
Vicksburg District, U.S. Army Corps of Engineers
4155 East Clay Street
Vicksburg, MI 39183

Dear Army Corps of Engineers,

I urge you to withdraw your effort to revive the environmentally catastrophic, grotesquely wasteful 'Yazoo Area Pumps Project' in Mississippi. No amount of NEPA hand waving can alter the dispositive, fatal errors of both fact and morality in the conceptual premises of the Yazoo Project. This project has lingered as a pet dream of major agricultural interests in Mississippi for decades, has been rightly and repeatedly rejected by the Army Corps and Engineers and the Environmental Protection Agency, including under the Bush Administration, because it would drain and eradicate 200,000 acres of the country's most precious wetlands in the watershed of Mississippi's Big Sunflower River. No facts have changed to warrant the Corps' attempt to evade or suborn this veto.

Rather than accept the implication of this fact, the Corps now seeks to subvert and disappear the long-established Clean Water Act review process for federal projects, nullify the considered judgment of agency scientists, and impose this gross caricature of home-state pork through raw political power. This represents an **explicit demand for the liquidation of one of America's irreplaceable biological Edens, in exchange for barren, vacant land to produce low-value commodity crops**. 200,000 acres of swamps, bayous, marshes, and bottomland forests will vanish, making a blatant mockery of repeated American commitments to staunch the loss of our wetlands. **A more profane theft against our children and our Planet Earth, for the most venal, parochial, selfish of reasons could not be fathomed.**

The Environmental Protection Agency vetoed the Yazoo project in 2008, owing to the outlandish and gratuitous ecological destruction it would cause, and the utter lack of any public interest in constructing one of the world's largest water pumping complexes in a sparsely populated region. **The Yazoo pumps would constitute a $300 million engineering subsidy to help landowners violently remake the landscape of Mississippi to their agricultural convenience**. The pumps' sole purpose is to move up to six gallons of water per minute from one side to another of a Corps' flood control structure, to **assist a handful of large landowners to increase production on lands that naturally, regularly flood and are inappropriate for agriculture**. This area already receives several million dollars federal subsidies annually, the highest payouts in Mississippi, due to regular flooding.

The Yazoo pumps represent a resurrection of a bygone era in hydrological engineering, deploying overwhelming force against the natural cycles, contours, and dynamics of the Earth's life support system. **The wetlands that will cease to exist include jewels of the Delta National Forest and four National Wildlife Refuges in Mississippi**, which the American people have invested dearly to protect for decades. More than 450 species of fish and wildlife, including 257 species of birds, rely on the wetlands to be drained by the Yazoo pumps. The public interest in maintaining these wetlands, and the right of the plants and animals to retain their homes in these wetlands, supersedes the avaricious, petty interests of agricultural interests in claiming a publicly subsidized production zone. These verdant, vibrant remnants of America's biological heritage defy any financial tabulation, and to **deny our children the Big Sunflower River wetlands, as their rightful inheritance, would be a moral crime beyond any redemption for the Corps.** It would serve no purpose but to surrender more fragile floodplains to production of more of the commodity crops from which America is already suffering a gross overproduction, and for which USDA already pays millions to render economically viable.

Rather than spend $300 million on crude, brittle, sprawling water engineering that would be only marginally effective by the Corps' own admission, **the federal government could compensate agricultural landowners by a similar amount to fallow their inappropriately located cultivation, and allow this flood-prone land to return to marshes and forests**. This would fully eliminate financial risk for the relevant farmers, immensely benefit the wetland ecosystem species that have already lost so much Mississippi River wetlands, and restore wetland functions of absorption and storage that will mitigate risk to remaining landowners. The superiority of a natural restoration alternative to the Yazoo pumps fiasco is obvious by every metric, and should have concluded the NEPA process years ago.

Again, I urge you **withdraw this effort to resurrect this ecological, moral, and fiscal travesty known as the 'Yazoo Area Pumps Project,' and accept the prior EPA veto**, whose warrant has only increased since 2008, as wetlands have continued to retreat across America before human consumption. The project exemplifies the very worst of parochial engineering on behalf of narrow agricultural interests, rendering the Corps a private engineering service to subsidized floodplain farmers. The selfish, parochial demands of the Mississippi delegation are to be expected from politicians advocating their wealthiest constituents' expropriation of public resources, but **bear no relevance to your consideration of the American public interest.**

Sincerely,

Jim Steitz

August 1, 2024

Mr. Mike Renacker
Vicksburg District, U.S. Army Corps of Engineers
4155 Clay Street
Vicksburg, MS 39183

Re: Yazoo Backwater Area
Water Management Project
Draft Environmental Impact Statement

Dear Mr. Renacker

I'd like to thank you and your team for working tirelessly on the subject project. I attended the virtual public meeting on July 16, 2024, all three (3) public meetings in Rolling Fork on July 22, 2024, and all three (3) public meetings in Vicksburg on July 23, 2024. I thought all seven (7) meetings went great and I really appreciate the interagency collaboration between USACE, USEPA and USFWS. I would love to see an earlier pump-on date and lower drawdown elevation, but after reviewing the final array, I'm in favor of Alternative 2 as it offers the most protection for myself and my neighbors.

I was raised in Issaquena County and went to Sharkey-Issaquena Academy in Rolling Fork, MS. I currently live on Herman Road in Grace, MS. It is obvious that without pumps our community cannot attract industry and without industry our population will continue to diminish. As a lifelong resident of the Delta, I have seen so many friends leave our area. I had 31 students in my kindergarten class, but in 2003 I graduated with only 14 classmates because more than half had moved away. This trend did not stop when I graduated 21 years ago - Our local Deer Creek Pilot newspaper recently had "**SIA will open, no sports**" in big bold print across the front page. If you were to read the paper you would quickly realize there are no sports because there are not enough students. The article quotes Head of School Mrs. Sadie Hester "the school currently has four (4) seniors enrolled, a few juniors, and a few seventh graders. There are no students enrolled in the eighth, ninth or tenth grades". I am sure a lot of today's lack of students is attributed to the EF4 tornado that stormed through our troubled community last year, but I can only imagine how different things would be if those pumps that were promised some 83 years ago were in-place.

A few years ago, I purchased 120 acres of hunting land that is located on the banks of Steele Bayou in Issaquena County. This land has been in my dad's family for nearly 35 years and has never experienced flooding as it did in 2019.

My land is nearly 40 Miles upstream of the Steele Bayou Structure and still experienced excessive long-term overbank flooding in 2019! Unlike the project opponents, I have seen the damage that was caused to the wildlife and trees firsthand - and contrary to what those same project opponents say, I am NOT a farmer and the pumps will definitely benefit me.

John Dustin Herman ▪ 31764 Highway 1 N ▪ Mayersville, MS 39113

Today, nearly every time I try to drive the roads through my property, I must clear fallen hardwood trees that have died as a direct result of the backwater floods we experienced 5 to 6 years ago. These floods also caused erosions and excessive damage to culverts and other drainage structures on my property. Not only did the backwater push out or kill the wildlife on my land, it also left behind deposits of old plastic bottles, old coolers, old herbicide containers and other unwanted debris.

As the 2019 backwater receded from several months of overbank flooding, it also caused widespread bank sloughing along the interior streams. This was not just on my land, it's throughout the entire backwater area. You can see it on the Big Sunflower River, the Little Sunflower River, Steele Bayou, and many other interior drainage ditches. I know I have personally seen it while driving through Holly Bluff, Grace, Delta City, Eagle Lake, Onward and I'm quite certain it can be found elsewhere. The sediment and silt bars that deposited because of banks sloughing off only compounded the drainage issues we already had in our area – as most of the interior streams were already lacking much needed maintenance because they have not seen a major Corps of Engineers cleanout/dredge project in over 65 years.

Unlike nonresident project opponents, I truly love this place that I call home and would love to see the 25,000 cfs pump station in Alternative 2 constructed. This would help protect the trees, the wildlife, the environment, and most importantly my family, friends, and neighbors and each of our lifelong investments we have worked so hard to protect.

I'm asking you to please give us the help we so desperately need and deserve!

Thanks again and please feel free to contact me to look at any of the issues I have mentioned in this letter – I would be happy to show anyone around.

Sincerely,

John Dustin Herman, P.E.
(662) 820-9337

BOARD OF
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August 23, 2024

Vicksburg District, USACE
Attn: Mr. Mike Renacker
4155 Clay Street
Vicksburg, MS 39183

Re: Comments on the Yazoo Backwater Project Draft EIS

Dear Mr. Renacker,

The Mississippi Levee Board wants to thank the U.S. Army Corps of Engineers (Corps), the Environmental Protection Agency (EPA), and the U.S. Fish & Wildlife Service (USFWS) for working together to come up with a solution for our Backwater Flooding problem! **We prefer Alternative 2 with a 25,000 cfs Pumping Plant that turns on at 90' starting March 16th each year.** Both Alternatives 2 and 3 will protect people, homes, roads, farms, infrastructure, wildlife, fish, trees and the environment. The Federal Family of the Corps, EPA and USFWS have worked together to develop this brand new project for the South Delta. This project is compliant with the Clean Water Act and meets the needs of the community.

Alternative 1 is no action, do nothing, in other words keep letting the area flood. This Alternative 1 has absolutely no support! We have been living with the "do nothing" plan for 83 years and we have seen the devastation to the economy, infrastructure, homes, lives, crops, wildlife, trees and the environment. **Alternative 1 is not an option!**

Alternative 4 is the nonstructural only plan. This Alternative 4 has no local support. Another problem with this Alternative 4 is that is only takes care of structures and land that was flooded in 2019. In 2019 the backwater reached 98.2'. This is the 35-year flood. The 100-year flood is 100.5'. At a minimum this Alternative 4 should take care of all the structures and land in the 100-year flood - not a 35-year flood. The major objection to Alternative 4 or any other fully nonstructural plan is that it does nothing to protect the wildlife, trees and environment. These resources will continue to die and the eco-system will further decline with a nonstructural alternative. There are several national environmental groups that have historically opposed the project and have created a "click and send" form letter email that goes directly to the Corps. They use a short introduction overview full of misleading information to incite their members and they encourage them to "click and send" these emails to oppose the pumps and support the nonstructural Alternative 4. They will send tens of thousands of mass emails to the Corps. Please note that these emails will come from all over the United States and that these people do not know the facts and they have no idea where the Yazoo Backwater Area is located. Please dismiss these emails as a mass campaign to sabotage the Pumps. **Alternative 4 is not an option!**

During the Virtual Public Meeting held July 16th there were 10 comments in the chat box - all 10 supported the 25,000 cfs pump and all 10 specifically wanted Alternative 2. During the Public Meetings held in Rolling Fork, MS on July 22nd there were 35 people who made statements. All 35 supported the pump and 24 specifically wanted Alternative 2. During the Public Meetings held in Vicksburg, MS on July 23rd there were 34 people who made statements. All 34 supported the pump and 28 specifically wanted Alternative 2. When you total up all these statements you had **79** people who made statements. All **79** supported the pump and **62** specifically wanted Alternative 2. **During the virtual meeting and all the public meetings the support for the 25,000 cfs Pump was unanimous!**

The local community wants the 25,000 cfs pump that will protect to 90' during the crop season and 93' during the non-crop season. Alternative 2 and Alternative 3 are the only options!

We prefer the earlier turn-on date of March 16th because we have an agricultural-based economy here in the Mississippi South Delta. Even if you are not a farmer, a lot of jobs and businesses in this area depend on farming to make a living. But we also understand that in the past 46 years the pumps would have only cut on before March 25th 6 times to maintain 90' (1994, 1997, 2016, 2018, 2019 & 2020). That averages to be only once in every 7 years. Historically, the vast majority of backwater floods reaching 90' happen in the April/May timeframe.

We want the required mitigation lands to be obtained voluntarily as a reforestation easement instead of only in fee title. A few landowners might want to sell their land but the vast majority will only want an easement. I do not think the Government wants to acquire a bunch of little tracts spread out all over the place - it would be impossible to manage. Plus when the Federal Government buys property - the counties stop receiving annual taxes on it. Let the property owner keep the property and that way they can enjoy the recreational opportunities, maintain it, and still pay taxes to their respective counties.

We want to change "mandatory" acquisition of all structures (101 structures) below 90' to "voluntary" acquisition. I can't believe there is anyone living in a house below 90' - especially when we have seen 90' 22 times since 1979. Also we reached 95.2' or higher 3 years in a row in 2018, 2019 & 2020! But if there is anyone living in a house below 90' then give them an option to buy them out or let them stay and help protect them.

This project is an Environmental Justice project! 71% of the population is minority and 30% live below the poverty line. This project will help our minority and impoverished community.

The Steele Bayou Drainage Structure was completed in 1969 and is now 55 years old. The top of the Steele Bayou Structure curtain wall is 108.5' msl. In the next few years we will be raising the Yazoo Backwater (YBW) Levee up from 107' msl. The authorized grade for the YBW Levee is 112.8' msl. Since the Steele Bayou Structure is older than 50 years and modifications will have to be made to it when we raise the YBW Levee we request that the superstructure being built for the 25,000 cfs Pumping Plant includes a gravity flow drainage structure capable of passing 50,000 cfs and is built above 112.8' msl.

We request that the Final EIS contain all the data and results of the Recommended Plan going forward. For instance, the current 100-year flood for the area is 100.5' and with the implementation of the 25,000 cfs pump it will drop the 100-year flood to 93.5'. This is very relevant data that shows the real and direct positive impacts of the Recommended Plan.

Most people looking at a 1,000 page EIS usually only read the Executive Summary found in the beginning of the document. We found the Draft EIS Executive Summary to be lacking. In fact, we found that the Draft EIS Conclusion (Section 9) located at the very end of the Main Report to be more helpful than the Executive Summary! Knowing that 99% of the population will only look at the Executive Summary in the Final EIS we ask that you do a good job in briefly and clearly explaining the details of the Recommended Plan. Please include the mitigation requirements and list the impacts, pertinent facts and data in this Final EIS Executive Summary.

The Mississippi Levee Board appreciates this Draft EIS and we look forward to the Final EIS and the signing of the Record of Decision. This project is the result of a promise made by the Federal Government 83 years ago in 1941. **Please move forward with completing the Environmental Documentation so we can start construction as soon as possible so we can Finish the Pumps!**

BOARD OF MISSISSIPPI
LEVEE COMMISSIONERS

Peter Nimrod, P.E., P.L.S.
Chief Engineer

OPTION #2

Taken from article written by PATRICK DURKIN May 11, 2020

Turkeys starved in treetops. Ravenous raccoons killed nesting turtles and newborn fawns. Countless other wild animals perished during a record 219-day flood last year in Mississippi's Yazoo Backwater Project.

The Yazoo Backwater's surrounding levees provided the only high ground for displaced wildlife, but all those miles of manmade barriers provided little sanctuary throughout the unprecedented deluge. The Backwater, or South Delta, covers about 1,550 square miles of fertile valley in west-central Mississippi north of Vicksburg, where the Yazoo River flows into the Mississippi River.

The Yazoo Backwater reached flood stage (87 feet) on Jan. 4, 2019, peaked at a record 98.2 feet on May 23, and stayed above flood stage until Aug. 10. The flood's crest coincided with the region's peak nesting and fawning periods, crushing populations of wild turkeys, whitetail deer, and ground-nesting birds.

The Backwater's floods also drowned two people, covered three highways, and swamped or destroyed 686 residences. The seven-month flood caused at least $800 million in agricultural losses and damage across half a million acres of farm fields.

When the stagnant waters finally receded in late summer, residents and business owners returned to homes and buildings fouled by sewage, garbage, agricultural chemicals, snakes, and rotting animal carcasses. Unfortunately, sustained rain and prolonged flooding returned this year, furthering the losses of homes, property, croplands, and wildlife.

Devastated Wildlife

William McKinley, deer program coordinator for the Mississippi Department of Wildlife, Fisheries, and Parks, said the Backwater's 2019 fawn "crop" was devastated. So was the entire turkey population. Agency biologists and researchers at nearby Mississippi State University documented only four turkeys in 8,790 wildlife photos taken in October 2019 during a month long post-flood study using 300 trail-cameras. That study on the Shipland Wildlife

Management Area, one of seven WMAs that flooded, also estimated a 5% fawn survival rate.

The biologists conducted weekly deer surveys along a 26-mile route on the Backwater's southwestern levees. They regularly photographed emaciated deer and counted 503 dead whitetails from mid-June to early August. They necropsied deer when possible, and attributed most deaths to starvation and heat exposure. And because this is where Mississippi first detected chronic wasting disease in February 2018, they also collected tissue samples for CWD tests.

Much of the devastation occurred on levees flanking the Yazoo Backwater's western border with the Mississippi River and its eastern border with the Yazoo River. If this were an animal horror movie, warning signs on the levees would read, "Abandon hope all ye who enter here." Everything that could fly, walk, crawl, or slither sought refuge on the containment walls. Once there, they fought for food, shelter, and shade—all of which were scarce.

McKinley said starving raccoons proved a nuisance and nemesis to all. They honeycombed the levees by digging burrows for shelter, making it difficult for agency and university biologists to walk without stepping into holes.

"I figured the raccoons would live up in the trees, but they settled into holes all across the levees and stayed," McKinley said. "You had to be careful where you stepped. Every 25 yards you'd find a hole with a raccoon in it. We have no idea how many were out there, but they were dying, too. They were in poor condition; unkempt and unaware, and in really poor health. When they were scavenging something, we'd get within 4 to 5 feet before they realized we were there."

Turtle Carnage

When the biologists weren't dodging raccoons and their burrows, they were driving or stepping around their means to survival.

"Empty turtle shells from red-eared sliders were everywhere," McKinley said. "There were thousands of them. One time we saw three raccoons tussling over a big red-eared slider. All the female turtles were on the levees. They had nowhere else to lay their eggs. The raccoons figured them out quickly. They chewed off a rear leg, reached up inside for the eggs, cleaned everything out, and moved on to the next one. They picked them clean. Those turtle shells looked like they'd been steam-washed."

McKinley thinks raccoons also killed newborn fawns soon after birth. Every pocket of shade held animals, so pregnant does couldn't seclude themselves when fawning.

"I can't document it, but it looked like the raccoons just gathered around the does and waited for fawns to drop," McKinley said. "I firmly believe that. The only broken bones were the fawns' ribs, so I doubt something bigger killed them and that the raccoons just cleaned things up. All the bigger bones were chewed, not broken. All the meat was picked clean."

McKinley said those scenes were among the flood's many unexpected sights and behaviors. During most floods elsewhere, deer flee lowlands for the nearest hills and higher ground. Some deer from the Yazoo Backwater probably did, too, but many did not. Those remaining spent so much time in water that their hooves grew soft with rot. McKinley also recalled counting 1,200 deer scouring a field in 12 inches of standing water on a hot day, three hours before dark.

"We can't explain why so many deer stayed," McKinley said. "They have ways to get out, but it's not easy. On the other hand, assuming some deer fled, if they had CWD they carried it to new areas. We have lots of questions that will take a while to answer."

McKinley said most songbirds also fled the Backwater, but there was no escaping the stench of death and unique, unexplained oddities. Paper wasps, for instance, usually build their papier-mâché nests just off the ground in low brush. But with floodwaters covering brush and reaching far up trees and powerline poles, the wasps built their volleyball-size nests on the powerline's thick wires.

"We'd be driving along and see a wasp nest on a wire, and wonder why would they build there with trees everywhere," McKinley mused. "But then we'd see another nest, and another and another up on the wires."

Turkey Struggles

The Yazoo Backwater's wild turkeys, however, left scant evidence of their presence or passing. Adam Butler, wild turkey program coordinator for the Mississippi DWFP, said the area's turkey flocks had already declined much of the past decade because of frequent flooding, but brood surveys in 2018 suggested a considerable boost for the population.

Unfortunately, last year's flood made poult production impossible, and Butler worries the flock lost the previous year's gains, and maybe more. He said turkeys can't live and forage for long in treetops, and can't find food closer to the ground during floods. That's not just Butler's opinion. He references research by Michael Chamberlain, a recent guest on the MeatEater Podcast (Episode 214), who documented only one in five adult turkeys he monitored in 2011 survived a month-plus flood farther south in the Atchafalaya Basin.

Chamberlain noted that turkeys move to higher ground if they know it exists. But if that ground isn't high enough to escape floodwaters, turkeys just keep searching their known turf until starving to death. At least that's what Chamberlain's GPS-collared turkeys showed.

Here's how that went: A bobcat killed one hen the day the flood began. Another hen lived 21 days, and a third disappeared. It's unknown if the missing hen's collar malfunctioned or got destroyed in the flood. The lone surviving hen found dry ground 29 days into the flood as waters receded. The lone tom should have stuck with her. It died in a water-inundated area 31 days into the flood.

"Turkeys aren't like deer," Butler said. "Turkeys typically stay near home. They don't know the land beyond the horizon."

Butler said the Yazoo Backwater's turkey flock typically isn't large, and usually cycles with regional flooding. The hatch booms to bolster the flock in years with short flood seasons, and busts in years with heavy flooding. Adults typically endure because most floods recede after two to three weeks. Insects and vegetation pop up soon after, and life goes on.

Watery Trend

That pattern fell apart the past decade because of prolonged rains and flooding. "Adult turkeys can't survive in the trees' canopy six to seven months like we saw last year," Butler said. "We expect their survival in the Backwater last year was very low. It's possible the survivors might pull off a hatch this year, but it's getting late [April 29] and the river is still at flood stage."

The 2019 flood and its harm to people, property and wildlife aggravates a long festering debate in the Yazoo Backwater and extended Mississippi Delta system, which spans 200 miles from Vicksburg to Memphis, Tennessee.

Levees on the valley's entire western edge protect it from the Mississippi River's floodwaters, and levees on its southeastern side protect it from the Yazoo River's floods. The land mass in between covers nearly 4,100 square miles, slightly smaller than Connecticut.

And here's the scary part: All water and waterways within the leveed valley have only one way out: a "bathtub stopper" called the Steele Bayou Structure upstream from the Mississippi River. When the Mississippi floods, the Army Corps of Engineers shuts the Steele Bayou control gates to prevent floodwaters from backfilling the Yazoo Backwater and larger Delta.

That's no small task. By the time the Mississippi River reaches Vicksburg, it's carrying 41% of the continent's runoff, which includes its own watershed starting in Minnesota; the Missouri River's watershed starting in Montana; and the Ohio River's watershed starting in Pennsylvania.

When a swollen Mississippi River forces Steele Bayou's floodgates to shut, residents pray that winter and spring rains stay away. If they don't, the Yazoo Backwater starts filling. Everything will be fine if the Mississippi River recedes before the Backwater reaches flood stage. If not, the 2019 scenario unfolds. (That buildup began in October 2018 with sustained heavy rains.)

The Backwater's original engineers considered such emergencies: They would build a giant pumping station at Steele Bayou once the structure was finished (1969). To prevent disasters like 2019, those pumps would evacuate rainfall trapped within the levees.

But the pumping station was never built. Funding squabbles between state and federal officials delayed construction for decades, and then the Environmental Protection Agency ruled against the pumps in 2008. Regional rainfalls since then have caused simultaneous flooding inside and outside the Backwater several times.

Conclusion

Meanwhile, hunting clubs, conservation organizations, and the Mississippi DWFP spent much of the 1980s and 1990s using the Conservation Reserve Program and Wetland Reserve Program to help improve the Delta area's turkey habitat. Butler hopes all that money and foresight wasn't in vain.

"A lot of those trees are now 25 years old, and turkeys can probably start using those areas over the next five years," he said. "We'd like to get back to doing some trap-and-release to help re-establish those flocks. It would make a great turkey woods if we give it the needed time. That would be a real success story."

Vmy 2pr

OPTION #2

To whom it may concern:

I am a retired Waterfowl Biologist. I spent the last 25 years of my career working in the South Delta area of Mississippi. As you know this area is actually in the northwest corner of Mississippi; not the present delta of the Mississippi River. However, it is made up of a lot of alluvial soils because of the history of the river and its tributaries in this area.

I want to tell you about my first experience in the South Delta. I graduated with my Masters in Waterfowl Management from Mississippi State University in 1990 with a thesis on the Wood Duck program at Yazoo National Refuge in the Delta. I was hired that fall by the United States Forest Service to work as a biologist on Delta National Forest which is in the heart of the South Delta. My first and foremost responsibility was to get the Green-Tree Reservoirs, part of the Yazoo Back Water Flood Control Project mitigation, ready to be pumped for wintering waterfowl. No problem! I worked with irrigation pumps, water control structures and flooding before—I got this!

Several weeks later, at a meeting with the entire Delta Staff, the field forester Ralph, mentioned to me that there was a species composition change and reduced diversity in the Forest due to the flooding, and said "check out your green-tree reservoirs". This was 1990. You have to understand Ralph; he gives you enough information for a valuable lesson or enough for you to hang yourself (I didn't know this at the time). I thought trees, especially ones here, should be able to handle winter flooding (by the way I grew up in Pennsylvania and moved to Mississippi to go to MSU from Montana/North Dakota); but, I had heard that Ralph was super smart and had been working on the Forest for a long time and knew his stuff. So I decided with about 9 GTR compartments we could flood 1/3 of them a year and that would give the forests a relief the other 2 years; hopefully providing wintering waterfowl with enough flooded water – I got this!

So choosing which GTRs to flood, I was on my way, easy-peasy! The fall and winter went well: Pumps worked, had enough water in the Sunflower River with the fall/winter rains, birds used the flooded areas, and visitors (hunters and bird watchers) to the forest were happy. Success!!!

Now, all I had to do was drain them appropriately and continue on with other projects. So, in March, I began to pull the boards that were holding water in the GTRs. I started pulling them one board at a time allowing for the water to lower slowly so invertebrates and other organisms could adjust to the lowering levels. In about a week, the Sunflower River started to rise. Maybe just a bit due to local rains, I thought. I continued pulling boards. Then the river was at the same level as my GTRs, then higher; so, I started putting boards back in. Oh yes, I had to put boards in the GTRs that were never flooded. The river kept coming up and overtopped the GTR boards and the actually levees, so now all GTRs were flooded even the ones I purposely didn't flood to help the trees. So I learned a valuable lesson, it wasn't the flooding of GTRs hurting the forests on Delta National Forest, but the rising of the Sunflower Rivers – ergo the back water flooding due to the lack of the Pumps.

So you can see, the back water flooding was degrading the forest on Delta National Forest before 1990. When I asked an employee recently why they have not been more vocal on this issue, they said they cannot comment on Political Issues. I hate that this has become a political issue. Professional working for State and Federal Agencies in the South Delta have their hands tied.

Please consider my letter, as a retired Wildlife Professional, support for the construction of the Yazoo Backwater Flood Control Pumps.

Kindest Regards

Jackie Henne-Kerr
39159 Highway 1, Rolling Fork MS
662-820-4783

OPTION #2 Using 2pm

Hi, Jackie Kerr. First, I want to say thank you for your time and effort you put into this extremely important issue to the South Delta.

Please count me as one who supports the Yazoo Backwater Pumps Option #2. I worked as a Waterfowl Biologist and Forest Manager in the South Delta for nearly 20 years. I want to speak for the wetland ecosystems in this area. The wetlands need a pump and option # 2 will serve them best.

As a biologist it didn't take but 3 months on Delta National Forest to become painfully aware of the issues with the Backwater flooding when I started working in 1990. It is very hard to manage wildlife habitat when it is flooded during the **growing season**. Even though this area was always influenced by water; first as a delta and then as a floodplain, THIS FLOODING IS DIFFERENT, IT IS MANMADE. The soil, flora and fauna evolved with winter flooding; not high water during the growing season. This MAN-MADE FLOODING during the summer is causing specie shift and diversity reduction and lack of plant growth and seed production so important for the bottomland hardwood ecosystems and especially wintering waterfowl.

I participated in a butterfly count on the forest last week. It was easy to see forest is being degraded due to this flooding. Someone new to the area could say what a beautiful forest and I would say you should have seen it in the 1990, But when I was there in the 90s, people said you should have seen it in the 40s and 50s. The effect of the 2019 and 2020 back to back summer flooding is obvious. There are so many dead standing and fallen trees. This is not the way a bottomland hardwood forest should look. It is not a healthy ecosystem.

Scientists have documented this decline. Look at pond berry colonies. Way down from 1990 to 2022. To halt and reverse this decline we need the pumps, removing the excess flood water in March. Look at forest health from the 1950 to now. Look across the river and at other backwater projects that have pumps – all is well including the forests and wetlands. I ask you to please be careful when very intelligent, is against the pumps because she says farmers pumping out of the shallow aquafer near her home south of Greenville caused their hand dug well to go dry. She could be right, but that is totally different pump situation. We have to believe in the science here.

Some say let nature take its course. I do believe mother nature knows best. But when man has modified a watershed as large as the Mississippi River's to the extent we have, our only recourse is to try to imitate mother nature in small areas like the south delta. By removing the excess water caused by man, we can let mother nature take it from there. Remember the wetlands especially seasonal ones which much of them are in the Delta get filled by winter rain, not river flooding. And the annual cycle of these wetlands -- they are full in March and began to dry down through evaporation and percolation till the center is a mud flat in July. **Each stage** of the water level produces different vegetation communities in rings around the wetland. The moist soil plants will grow and be a buffet for the wintering waterfowl as the fall and winter rains begin to fill them up. Then in March the annual cycle begins again ---IF and ONLY IF the pump will remove the excess flood water WHEN NEEDED.

Thank you for your time and effort to understand this complicated issue. And please push for option #2 which on the ground science has proven to be the best option for the bottomland hardwood ecosystems and wetlands we have here.

Jackie Kerr
Retired Waterfowl Biologist and resident of the South Delta
12315 Highway 1 Rolling Fork MS 39159
662-820-4783

[illegible] 2pm

Hi, Jackie Kerr retired waterfowl, biologist.

I was told I couldn't talk as long today as I did last time I was here, so I thought I better write down what I want to say. And that is just thank you. You were asked to find a solution to this problem with a new set of eyes and ears — that's like a judge telling the jury to disregard that last statement. Is that possible? Obviously so because you did it. You disregarded what was said on either side for the past 20 years, you disregarded politics, you looked at what was being said not who said it nor how many times something was repeated, you looked at the research, not the conclusions others drew from it. You used your compassion, knowledge and experience and came up with a plausible solution for everything and everyone.

We are indebted to you and I hate to ask you for more: but I'm am. When you get back to the hill, please do everything in your power to get this project with no strings attached initiated right away, the construction started and completed as soon as possible. I for one am looking forward to seeing the south Delta, Delta National Forest, and other wetlands habitats on the right path back to being what they should be. And if there's anything we can do to expedite this, please let us know. Again, Thank you, THANK YOU, Thank you.

OPTION #2

OPTION #2

Vmuy 2pm

To whom it may concern:

I am a retired Waterfowl Biologist. I spent the last 25 years of my career working in the Mississippi South Delta. I would like to discuss the annual cycle of the majority of wetlands which evolved as seasonal wetlands here. Many people think a wetland is a wetland! And I have noticed this is the theme to the negative comments about this project "destroying 1000s of acres of wetlands." This is just NOT TRUE. The acres of flooding will be reduced by 1000s of acres, but these acres are not wetlands; they are roads, houses, uplands, farm fields, etc.

Most of the wetlands here in the South Delta are not permanent, but seasonal wetlands. Historically they fill during winter rains, and are dry by July. The periodic spring flooding of the Mississippi River in past centuries did not have a significant impact on the evolution of these wetlands. If the River did overtop is banks, the flood waters rose over the already full wetlands and the ridges for several days in early spring than drained out. I want to summarize what the seasonal or monthly changes to these wetlands should be, without the prolong manmade flooding of recent decades; and how vegetation and waterfowl adapted to this natural rhythm.

This is a simplification, but I want to describe the seasonal progression of a wetland I managed focusing on ducks. The wetland is like a soup bowl; it has a slope from the edge or ridge, this slope goes down to a step or flat (where the parsley or other herb is sprinkled in a fancy soup bowl), then there is another slope to the bottom of the wetland or bowl (where the soup is). The difference between the wetland and the soup bowl is that the wetland has ridges in the bottom, most less than a foot high, but significant none the less (plus it is not round, but elongated because it is an old oxbow). So let me list the changes that should occur to the water and vegetation in my wetland as the year progresses.

- Starting in early spring: this seasonal wetland is full from the winter rains. If the river floods, it leaves quickly allowing the upland vegetation on the ridges around the soup bowl to begin to sprout, germinate, and leaf-out in

February and early March. The ridges have an overstory of red oaks, elms, sweetgum, pecan, and hickories; maples, mulberry, pawpaw and winged elm are in the understory. Ground cover species bloom quickly before the overstory steals all the sunlight; cane, vines and briers patches abound. My wetland is still full of water.

- March comes and goes, water in the wetland soak into the ground and begins to evaporate due to the warmer, sunny weather. The upper slope of the soup bowl begins to emerge as the water goes down. There is a new flush of green; a different type of trees, shrubs and herbaceous vegetation grow on this upper slope due to when the soil emerging from the water. Ridge species begin to fade out and later flushing nuttall, water and willow oaks, hackberry and persimmon are in this area and begin to green up.
- During April again evaporation and infiltration lowers the water in my wetland. The bottom of the upper slope is now greening up; and another ring of desirable vegetation will flourish.
- In May we have "snow storms" of willow and cottonwood seed floating on the winds trying to find a place to land and germinate. With the water levels dropping and the step becoming a mudflat, it is perfect timing for these trees to get started! If there are already cottonwood and willows established, the ground vegetation of smartweed and other wetland species flush out. Willow tree leaves are thin and drooping and cottonwood leaf petioles are flattened so the leaves hang down also, allowing for sunlight to reach the forest floor.
- As June progresses, the lower slopes of my wetland are now drying out. On this slope and on the ridges in the bottoms cypress grow. Buttonbush thickets form at the base of the cypress and on the ridges in the bottom of the wetland. These species can tolerate a lot of water, but not if it overtops the tips of the plants and stay too long into to July when the water will be so hot that it actually scalds the young trees and shrubs. Sedges and rushes also take hold in these areas when the water leaves at the right time.
- And then July comes; and it is hot and dry. The bottom of the slough is now a mud flat; grasses, millets and other warm season vegetation begin to grow. They have to grow fast, the bottom dries so quickly that they don't have much time before the moisture is gone. Woody vegetation doesn't grow in the bottoms normally, the season and moisture dictate what grows

here. By the end of July, the plants we call warm season grasses or moist soil plants have mature and will produce a layer of seeds sometimes inches thick in these bottoms. This seed bank is so important for the wildlife especially waterfowl and it NEEDS to be here in the bottom.

- Now it is August, the bottom of the slough begins to crack the moisture goes deeper and deeper into the ground. Cracks as wide as 6 inches and several feet deep are present throughout the bottom of my wetland. Nothing is growing, but the feast is laid in preparation for winter.
- September bring early fall rains. The cracks begin to close as the moisture gets closer and closer to the surface of the slough bottom. All other levels of the slough; bottom ridges, lower slope, the step and upper slope and ridges have vegetation maturing and getting ready for winter. Blue-wing teal pass through but this seasonal wetland is not ready for them, there is no pooling water.
- October/November brings other migrating waterfowl (mallards, wigeons, gadwalls and more) to the Delta. And water is beginning to pool in the bottom of my wetland. All those seeds are there for them to feast on and recuperate from their migration.
- December and more rain. Now the water in the slough bottom is too deep for dabbling ducks to get the seed; but that's ok in a normal year they probably already ate most of it and now the water depth on the ridges and lower slope is just right for them to get button bush and other seeds dropped there.
- January rains raise the water into the willow/cottonwood flats. In normal years the ground vegetation there is very leafy and it and the willow and cottonwood leaves and branches are perfect for aquatic insects to live. Waterfowl at this time are preparing for molt, migration, and egg production. The birds need these insect larvae for the required nutrients. Ducks are also beginning to make pair bonds, the water around the buttonbush branches and the willow and cottonwood trunks are necessary for seclusion.
- Its February again, water is now near the top of my slough, ducks are utilizing seeds and acorns in this area as they migrate out to their summer nesting grounds. The cycle ends and a new one can begin.

But what happens to my slough when flooding occurs like it did in 2019 and 2020. Water remained high in the slough, actually over the slough and the surrounding ridges. Vegetation did not flush when is should have because the water did not retreat it a timely fashion. Cottonwood and willow seeds never landed on mudflats, so they didn't germinate and were not available for wildlife to eat and nest in. briers did not grow, cane was under water and did not sprout, no vegetation grew in the bottom of the slough. Most animals died or at least were not able to nest and/or reproduce. When the slough did start to dry out in late July, no vegetation grew under the willow/cottonwoods it was too late in the season. Some vegetation like cock-a-bur did grow in August, but it is not a desirable or sustainable species for wintering waterfowl. As winter comes the birds will come, but there will be no food in my slough and they will leave. They will have to compete with other waterfowl in areas they are not familiar with and they might not survive. This excessive flooding is not something the vegetation and wildlife in the South delta can withstand yearly. Please realize this paragraph describes not only my wetland during 2019 and 2020. It is the scenario of all seasonal wetlands in the backwater flood area of the Mississippi Delta when we have water like we did in 2019 and 2020.

When I talk to others that have lived here in the South Delta longer than I have, I notice that these severe flooding events are happening more often and for a longer period of time. This, I am sure, can be attributed to more and more modifications of the Mississippi River watershed up river and to climate conditions changing causing more local rains in and around the Yazoo Backwater Area. These conditions are not going to go away. The wildlife and wetlands in this area need the pumps as much or more so than the residents and farmers. The pumps will be a win, win, situation for people and the natural resources in the South Delta. Please, build and utilize the pumps!

Thanks so much for listening,

Jackie Kerr,
Retired Waterfowl Biologist
12315 Highway 1
Rolling Fork, MS 39159
662-820-4783

OPTION #2 Vmmy 2pm

My name is Jackie Kerr and I am a retired waterfowl biologist and forest manager and I worked in the South Delta for about 20 years since 1990.

Points I would like to make to rebut some other statements.

1. "The pumps will not ONLY help the rich white farmers."
    a. The farmers (rich white, poor white, rich black, poor black) have insurance so when there are flood years like 2019 and 2020; it breaks their heart more than their bank.
    b. It is the community and residents that depend on the farmers that loose most of all.
        i. The restaurants that depend on the farmers feeding their planting and harvest crews will not have business if there is no planting or harvesting.
        ii. The seed, chemical, fertilizer, equipment, parts stores, those businesses that are in the south delta because of agriculture, will have no business if there is no farming for the year.
        iii. The laborers whether farm or other business will not be able to work if there is no agriculture for the year.
        iv. Other private businesses like independent truckers, electricians, lumber companies, daycares, barbers, you name it are in business because of the agriculture holds residents in the area and these businesses can survive.

    So, in actuality, everyone else will benefit more from the pumps than rich white farmer.

2. "Building the pumps will NOT destroy 300,000 acres of wetlands in the South Delta." Like mentioned in one article.
    a. There are only 290,000 acres of wetlands in the south delta – do I need to say more about that statement? Creative Marketing, maybe????
    b. The project is all but completed; the infrastructure - ditching, levees, gates, weirs, etc, is done. The only thing left to do is putting in the actual pumping station in, and this final proposal is to put the pumps where they were originally planned, and it is my understand that the pad dirt work is already completed.

    So, point blank, this information is not truthful. Unfortunately, the organization making this statement and other organizations against the pump stating the pump will be detrimental to wildlife and wetlands do not have active programs or people on site in the South Delta. Enough said!

1. As biologist, forest manager and conservationist working and living in the South Delta over the past 30 years, I am for the completion of the Yazoo Backwater Pumps Project by taking the final step and installing the pumps. I was excited to see the addition of wells placed in the north delta to maintain the aquatic streams and bayous that tend to

dry up in the summer. Living and working here in the South Delta has open my eyes to the uniqueness of the area and how the uncompleted Yazoo Back Water Pumps Project has affected it.

a. First let me describe some the wetlands in the South Delta; a significant number of wetlands are seasonal. They are like soup bowls spread out on a table. Between the soup bowls are the "ridges" there are also ridges along the creeks, rivers, and bayous; with one side usually, a high ridge while the other side is sloping due to river movement. Then also between significant creeks and rivers there are flat ridges where the farmland is now located as well as the towns. This is where the "Mound Builders" also had their communities and farmlands. And it hard to believe but there were a lot more people in these historical cultures living in the Delta than people live there now. The rainy season in the Delta is in the winter early spring. These rains fill up these seasonal wetlands, Not the Mississippi River! Similarly, to the seasonal wetlands, the shallow and deep aquafers are not replenished by the River.

b. The River built and shaped the Delta over millions of years. River flooding to the height of the 1927 and 2011 floods are labeled the 500-year flood. These levels have a 1/500th chance of happening each year. So, statistic says they can happen back to back or never. Some people think of these happening every 500 years. Then there are the 100 year floods and the 50 year floods that happen more frequently. BUT to have 2 500, 12 100 and over 20 50-year floods in a 100-year period didn't happen historically. So why now? MAN. It is not just happening in the Mississippi Delta or the areas that have similar back water projects on both sides of the river, but up stream. Think about how many thousands of acres of the Mississippi Watershed is paved over, has houses on, is ditched and has vegetation modifications. All this sends more water down the River to the gulf. With projects like this all we can do is try to mimic nature as best as we can to maintain the vegetation and wildlife that adapted to the historical conditions. The changes we made to the area in the last 200 years are happening to fast for the plants and animals to adapt.

c. So, what is the pooling of the yazoo backwater flood water doing to the wetlands and wildlife. Remember the over-the-bank flooding of the Mississippi River historically was due to snow melt from up stream. This happened in Feb/March. The river came up flooded out at different levels depending on the year into the floodplain and then receded quickly depending on the height 10 to 20 days. The river depth and width were able to contain other runoff throughout the rest of the year. No levees holding and gates and ditching holding and directing the water. The plants and animals adapted and flourished in these historical conditions. The trees even the cypress are deciduous; an adaptation to the winter storms when standing in water (less likely to windthrow with out leaves). They were dormant during the winter allowing the standing water in the winter to not affect their growth and health. The water left from the tree roots prior to leaf out. Thus, allowing for growth and root health. Some trees adapted (like willow and cottonwood) to leafing and seeding out later and are able to be at lower elevations in the wetlands with out being stresses. Cypress and Tupelo Gum are even later and have extra adaptations to deal with standing water later in the spring.

2017 OPTION #2 Young 2pm

Cathy: MS WILDLIFE FED

I see people are playing hardball about the pumps/no pumps issue and the Extravaganza. I am sorry to hear that. I do want to reiterate my feelings about the issue if it can help in any way.

The "pumps/no pumps" is not a cut and dry issue. As a practicing waterfowl biologist in the south delta for over 10 years, I have had my share complications with the excess water that floods the south delta due to the drainage from the Yazoo Backwater Flood Control Project, the pumps would alleviate this problem. I do understand the big question of "how the pumps will be operated if put in."

Basically wetlands can be negatively affected by not enough water and too much water. I was constantly battling too much water in the south delta.

The wetlands here are also affected negatively by the excess water at the wrong time of year. When I was hired on Delta National Forest in 1990, we discussed the composition change and species richness reduction of the forests due to flooding. New to the area, I assumed flooding meant "flooding of the Greentree Reservoirs" for wintering duck habitat and hunting opportunities. We decided to rotate the flooding and flood every 3 years. After the winter season everything looked fine. 1/3 of the greentrees were flooded and 2/3s not. However, in March when I began to drain those that were flooded to imitate the natural drawdown, I ran into a real eye-opener, I was unable to remove the water for the growing season, because of the Little Sunflower River rising. By the End of March all the greentree levees were topped and I realized my error. The flooding was not due to my pumping the greentrees, but from the pooling of water in the south delta up against the gates. I recently asked a Forest Service employee, why they did not share this information during public hearings about the pumps. The reply was they do not get involved in Political Issues.

While working for James River, I managed the native stands of hardwoods as well as the wetlands for wildlife. During a year when the Mississippi River does not get too high and goes downs fairly early in spring, I could see how the seasonal wetlands progressed throughout the year. The water drained off ridges or outer ring of the wetland early in March leaving most of the oaks and other hard mast trees on dry ground. As April progressed, the next ring of the wetland became dry and the species tolerant to water during this time began to sprout and flourish. Then the shelf dominated by willows and cottonwood began to dry out throughout May; hence the "snowfall" of seeds early and late May. At this time the native ground cover plants get established and flourish in the muddy areas beneath these trees, In June the cypress/buttonbush areas begin to dry allowing for reestablishment of these species if necessary. Finally, in July the center of the wetland becomes a mudflat and the moist season vegetation can get established (grasses, sedges, millets and rushes). And then the wetland species take advantages of the sparse seasonal rains that fall in late summer and early fall. Basically the wetland is dry, but an abundant of seeds are produced and dropped. When the winter rains begin to fall, the seeds become available for wintering waterfowl. The dying vegetation a food source for invertebrates in the late winter and the cycle begins again. This scenario is not for all wetlands in the south delta, there are some that should dry faster and some that remain wet year round.

Recently there has been more and more excess yearly flooding and this year the wetlands I am speaking about are under about 15 feet of water and it is July. Historically, deviations occurred both flooding and drought, and these wetlands and associated habitat and wildlife survived. But recently due to the drainage project MINUS the pumps, excess flooding of these wetland has become the norm. The species cannot evolve fast enough to this man made flooding. The wetlands cannot function properly.

These wetlands I speak of are not farmland, but in forests like Delta National Forest, and other areas still wooded. These wetlands will not be harmed by the pumps but helped, with the caveat that the pumps are managed properly. And that is a big question mark, but without the pumps we know wetlands are being damaged, so let's work on making sure that the pumps are managed properly and we all can win. Perhaps we can use the pumps as leverage to have the wetlands of the north delta managed better???

Sorry so long winded. I just wrote this this morning and did not check for accuracy as to publish or share. So please do not use this as researched facts Just my observations with a lot of holes in it.

I would be happy to sit down with others to discuss this topic further and try to find a win-win solution given the present situation.

Jackie

Vmmy 2pm

OPTION #2

Edward E. Belk, Jr
Director of Programs
Missississippi Valley Division
US Army Corps of Engineers
Vicksburg District
ATTN: CEMVK-PPMD
4155 East Clay Street
Room 248
Vicksburg, MS 39183

Dear Sir:

I know the COE has been working in the South Delta for years and are asked again and again to do another study. I feel this request is just a way to postpone the completion of the Yazoo Backwater Project (Pumps) project. Or it is a fishing expedition from those against the pumps hoping to find evidence that the pumps are harmful. It is my understanding all the studies to date have not found that the Pumps will be harmful to the environment in this area.

I just want to emphasize the organizations and professionals that like you work in this area that are supportive of the pumps and some organizations that are supporting the pumps from afar.

Mississippi Department of Wildlife Fisheries and Parks voted in June 2019 to support the pumps because of the negative impacts on wildlife populations.

Nature Conservancy in Mississippi letter of August 2019 noting flooding imposes a tremendous burden on the natural resources.

Mississippi Forestry Commission pass a resolution in support of the Pumps March 10,2020 "adverse impacts on natural habitat, wildlife, and trees."

The Mississippi Wildlife Federation changed their position from against the pumps in their letter of intent to sue earlier this year.

Although I haven't found any documentation from the USFS against the pumps talking to past employees they have talked about the devastation that is being done on Delta National Forest. I personally worked on the DNF as a biologist in 1990 and was told by a forester that "the flooding was causing species composition change and reduction of species diversity". As the waterfowl specialist there I saw the negative impacts while trying to manage for wintering waterfowl.

Employees of the local USFWS have mentioned big trees falling due to the soil being waterlogged in the summer.) this is evident in most wooded areas in the South Delta after the 2020 flooding.

As a biologist for a timber company and working in the South Delta I can attest to the damage to the trees and wildlife in the area.

The Audubon Society as far as I know has not changed their position against the pumps, but their article against the pumps is not as prominently displayed. I had read several comments about the areas from retired professionals in the South Delta showing that the article has several inaccurate statements in it. I wonder when they say the pumps will drain 200,000 acres of wetlands and other sources are saying 200,000 acres of farmland are flooded. Are they the same acres? If the 200,000 acres of farmland is flooded, then the acres of actual wetlands are flooded also. And too much water in a wetland during the summer month is as more detrimental than not enough. I also just realized that Audubon Society does not have an office in Vicksburg anymore.

I have talked to foresters, biologists, conservation officers, land managers that have worked or are still working in the South Delta Area. We are all in agreement the pumps will help wildlife and habitat.

Please do your best to convince the EPA that the Pumps will be alleviating man made flooding and will help the communities and wildlife in the Delta.

Kindest Regards,

Jackie Kerr; Retired Biologist/Forest Manager
James River/Tembec, Fitler MS
Present Personal information: 12315 Highway 1, Rolling Fork MS. 662-820-4783

07-18-24

SIR

we need to get THE pumps going. floods destroy wildlife & Timber

THANK you

ROBERT STIGALL
408 SANDY BAYOU Rd.
ANGUILLA, MS. 38721

COMMENT CARD

Yazoo Backwater Area Water Management
DEIS Public Meeting

* Please note all fields are optional.

Name: Presley Gates Phone: 762-207-4153

314 Austin Loop Ft. Moore, GA 31905
Address:

presleyauer3@gmail
Email:

AREAS OF CONCERN

* Check all that apply.

- [x] Home Accessibility
- [x] Housing or Property Impact
- [x] Access to Emergency Services
- [x] Impacts to Wildlife
- [ ] Other: ______
- [x] Impacts the wetlands/environment
- [x] Infrastructure (Electricity or Road Accessibility)
- [x] Agriculture (Flooding of Farmland or Loss of Livestock)
- [x] Hunting or Outdoor Recreation

COMMENTS, QUESTIONS OR SUGGESTIONS:

We are in favor of alternative #2. Please consider tweaking the pump on date & elevation level.

7

COMMENT CARD

Yazoo Backwater Area Water Management
DEIS Public Meeting

* Please note all fields are optional.

Name: Claiborne D. Adcock, Jr.

Phone: (662) 571-2077

Address: Decatur, GA 30033

Email: claiborne.adcock@gmail.com

AREAS OF CONCERN

* Check all that apply.

- [x] Home Accessibility
- [x] Housing or Property Impact
- [x] Access to Emergency Services
- [x] Impacts to Wildlife
- [x] Impacts the wetlands/environment
- [x] Infrastructure (Electricity or Road Accessibility)
- [x] Agriculture (Flooding of Farmland or Loss of Livestock)
- [x] Hunting or Outdoor Recreation
- [ ] Other: ______

COMMENTS, QUESTIONS OR SUGGESTIONS:

I'm a landowner in the YBW area & support Alternative #2 with attention to possible adjustments for pump turn-on dates & turn-on elevation

COMMENT CARD 4

Yazoo Backwater Area Water Management
DEIS Public Meeting

* Please note all fields are optional.

Name: Charles Auer

Phone: 706-682-0490

Address: 1030 Christmas Ct
Midland, GA
31820

Email: rangerauer@gmail.com

AREAS OF CONCERN

* Check all that apply.

- [x] Home Accessibility
- [x] Housing or Property Impact
- [x] Access to Emergency Services
- [x] Impacts to Wildlife
- [x] Impacts the wetlands/environment
- [x] Infrastructure (Electricity or Road Accessibility)
- [x] Agriculture (Flooding of Farmland or Loss of Livestock)
- [x] Hunting or Outdoor Recreation
- [ ] Other: ______

COMMENTS, QUESTIONS OR SUGGESTIONS:

We're in favor of alternate #2 -

COMMENT CARD

Yazoo Backwater Area Water Management DEIS Public Meeting

* Please note all fields are optional.

Name: Joy Boyd

Phone:

Address: 559 Boyd Rd
Holly Bluff, Ms
39088

Email: JoyKBoyd@BellSouth.net

AREAS OF CONCERN

* Check all that apply.

- [x] Home Accessibility
- [x] Housing or Property Impact
- [x] Access to Emergency Services
- [x] Impacts to Wildlife
- [x] Impacts the wetlands/environment
- [x] Infrastructure (Electricity or Road Accessibility)
- [x] Agriculture (Flooding of Farmland or Loss of Livestock)
- [x] Hunting or Outdoor Recreation
- [ ] Other: ____________________

COMMENTS, QUESTIONS OR SUGGESTIONS:

I'm in favor of alternative #2. Please consider the pump-on date and elevation level.

COMMENT CARD 2

Yazoo Backwater Area Water Management DEIS Public Meeting

* Please note all fields are optional.

Name: LAURA AUER
Phone: 706-682-0490

Address: 1030 Christmas Ct
Midland, GA 31820

Email: auersx6@yahoo.com

AREAS OF CONCERN

* Check all that apply.

- [x] Home Accessibility
- [x] Housing or Property Impact
- [x] Access to Emergency Services
- [x] Impacts to Wildlife
- [x] Impacts the wetlands/environment
- [x] Infrastructure (Electricity or Road Accessibility)
- [x] Agriculture (Flooding of Farmland or Loss of Livestock)
- [x] Hunting or Outdoor Recreation
- [x] Other: ____

COMMENTS, QUESTIONS OR SUGGESTIONS:

We are in Favor of alternate #2

COMMENT CARD

Yazoo Backwater Area Water Management
DEIS Public Meeting

* Please note all fields are optional.

Name: Grant Auer

Phone: 762·207·4152

Address: 15 11th Street
Columbus, GA 31901

Email: grant.auerb@gmail.com

AREAS OF CONCERN

* Check all that apply.

- [x] Home Accessibility
- [x] Housing or Property Impact
- [x] Access to Emergency Services
- [x] Impacts to Wildlife
- [x] Impacts the wetlands/environment
- [x] Infrastructure (Electricity or Road Accessibility)
- [x] Agriculture (Flooding of Farmland or Loss of Livestock)
- [x] Hunting or Outdoor Recreation
- [ ] Other: ______

COMMENTS, QUESTIONS OR SUGGESTIONS:

I'm in favor of alternative 2 - I also wish you would consider tweaking the pump-on date and elevation level.

6

COMMENT CARD

Yazoo Backwater Area Water Management DEIS Public Meeting

* Please note all fields are optional.

Name: Warner Adcock

Phone: (662) 571-1493

Address: 1018 McDonnell Dr. Decatur, GA 30033

Email: warner.adcock@gmail.com

AREAS OF CONCERN

* Check all that apply.

- [x] Home Accessibility
- [x] Housing or Property Impact
- [x] Access to Emergency Services
- [x] Impacts to Wildlife
- [x] Impacts the wetlands/environment
- [x] Infrastructure (Electricity or Road Accessibility)
- [x] Agriculture (Flooding of Farmland or Loss of Livestock)
- [x] Hunting or Outdoor Recreation
- [ ] Other: ______

COMMENTS, QUESTIONS OR SUGGESTIONS:

I'm a landowner and support alternative #2 with adjustments to turn-on + dates for the pumps.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
ATLANTA, GA 30303

August 27, 2024

Colonel Jeremiah A. Gipson
District Engineer, Vicksburg District
U.S. Army Corps of Engineers
4155 East Clay Street
Vicksburg, MS 39183

Re: EPA Comments on the Yazoo Backwater Area Water Management Project Draft Environmental Impact Statement; Humphreys, Issaquena, Sharkey, Warren, Washington, and Yazoo Counties, Mississippi, and Madison Parish, Louisiana; CEQ No: 20240114

Dear Colonel Gipson:

The U.S. Environmental Protection Agency has reviewed the U.S. Army Corps of Engineers Draft Environmental Impact Statement (EIS) for the Yazoo Backwater Area Water Management Project, which was published on June 28, 2024. The draft EIS was reviewed in accordance with Section 102(2)(C) of the National Environmental Policy Act and Section 309 of the Clean Air Act. The CAA Section 309 role is unique to EPA. Among other things, CAA Section 309 requires EPA to review and comment on the environmental impact of any proposed Federal action subject to NEPA's environmental impact statement requirements and make the agency's comments public. The USACE is the lead Federal agency for the project, and the non-Federal sponsor is the Board of Mississippi Levee Commissioners. The EPA is a cooperating agency on the project.

Pursuant to a Joint Memorandum of Collaboration, signed January 2023, the USACE and the EPA have worked collaboratively on the Yazoo Backwater Area Water Management Project. The USACE, the EPA, and the U.S. Fish and Wildlife Service participated in joint public engagement sessions on February 15, 2023, and May 4 and May 5, 2023. The EPA provided scoping comments to the USACE on August 7, 2023. The EPA also attended cooperating agency meetings beginning September 14, 2023, and public meetings on the draft EIS on July 22, 2024, and July 23, 2024.

According to the draft EIS, "*[T]he primary purpose of the project is to reduce flood risk from flooding in the lower Mississippi Delta caused by excessive standing water for long periods of time.*" The draft EIS also states, "*[T]he proposed plan would provide significant flood risk reduction for communities in the Yazoo Backwater Study Area, or YSA, and the local economy while also avoiding and minimizing impacts to important environmental resources.*" The draft EIS evaluated the following alternatives: (1) Alternative 1 (No Action); (2) Alternative 2 (Crop Season 16 March – 15 October and Non-crop Season 16 October – 15 March); (3) Alternative 3 (Crop Season 25 March – 15 October and Non-Crop

Season 16 October – 24 March); and (4) Alternative 4 (Nonstructural Plan Only). The draft EIS identifies Alternatives 2 and 3 as the preferred alternative.

Alternatives 2 and 3 include the same structural and nonstructural components, and only differ in the dates of water level management, specifically the dates identified as the crop season and the non-crop season. The structural components of Alternatives 2 and 3 include the construction and operation of 25,000-cubic feet per second pump station, adjacent to the Steele Bayou water control structure. Water levels would be managed at 90 feet National Geodetic Vertical Datum of 1929 (NGVD29) at the Steele Bayou gauge during crop season and up to 93 feet NGVD29 during non-crop season. Thirty-four supplemental low-flow groundwater wells would be installed. The nonstructural components include full utilization of the gate operation of the Steele Bayou water control structure to optimize fisheries exchange (75.0 feet NGVD29) as described in the current water control manual. Mandatory acquisition of residential and commercial properties up to 90 feet (101 structures); voluntary floodproofing and/or acquisition of properties up to 93 feet (231 structures). Voluntary acquisition of up to 11,816 acres of cleared land at or below the 2-year floodplain, and up to 27,675 acres of cleared lands between the 2-year and 5-year floodplains, through fee or a restrictive easement.

Another important component of Alternatives 2 and 3 is the development of three Memoranda of Agreement between the Department of the Army, the USFWS, and the EPA, which are to be finalized before the publication of the final EIS. The first MOA is an agreement on the final water control operations. The second MOA is a joint mitigation agreement. The third MOA is an agreement to collect and evaluate monitoring data across the YSA.

Based on the review of the available information, the EPA has identified public health, welfare, and environmental quality concerns in the analysis that are recommended to be addressed in the final EIS. Alternatives 2 and 3 would have adverse impacts to the environment requiring mitigation along with an associated monitoring and adaptive management plan. Enclosed are detailed comments and recommendations regarding alternatives; aquatic resources; hydrologic, hydraulic, and water extent and duration analyses; water quality; environmental justice; air quality; costs and benefits; and transportation. Comments and recommendations regarding the Clean Water Act Section 404(b)(1) evaluation, which is needed before a Record of Decision is issued, are also included. These recommendations are intended to help improve the environmental outcome of the proposed action.

The EPA appreciates the opportunity to review and comment on the draft EIS. If you have any questions, regarding our comments and recommendations, please contact Wm. Kenneth Dean, Acting NEPA Section Manager, at 404-562-9378 or at dean.william-kenneth@epa.gov, or Douglas White of the NEPA Section at 404-562-8586 or white.douglas@epa.gov.

Sincerely,

JEANEANNE GETTLE

Digitally signed by JEANEANNE GETTLE
Date: 2024.08.27 16:30:13 -04'00'

Jeaneanne M. Gettle
Acting Regional Administrator

Enclosure: Detailed Technical Comments

Enclosure
Detailed Technical Comments on the Draft Environmental Impact Statement
for the Yazoo Backwater Area Water Management Project
CEQ No: 20240114

Background

Flood risk reduction for the entire Yazoo Backwater Area was authorized by the *Flood Control Act of 1941*. Since authorization and subsequent modification, the USACE has completed construction of extensive flood risk reduction features in the Yazoo Backwater Study Area, or YSA. This infrastructure has significantly reduced the frequency and duration of flooding in the YSA from the Mississippi River and includes levees, associated drainage channels and water control structures. Despite implementation of these flood risk reduction features, flooding in the YSA continues to occur during high Mississippi River events that result in the closure of the Steele Bayou water control structure causing rainfall that occurs within the YSA basin to accumulate within the YSA. This flooding is known as backwater flooding.

I. Alternatives

The USACE developed three action alternatives to address these remaining backwater flooding concerns in the YSA and the draft Environmental Impact Statement (EIS) analyzes and compares the impacts associated with these alternatives as well as the no action alternative, described as follows.

- **Alternative 1:** The No-Action Alternative.
- **Alternative 2:** Structural and nonstructural alternative.
  - Structural components: This alternative would construct and operate a 25,000-cubic feet per second pump station, adjacent to the Steele Bayou water control structure. Water levels would be managed at 90 feet National Geodetic Vertical Datum of 1929 (NGVD29) at the Steele Bayou gauge during crop season (March 16 – October 15) and up to 93 feet NGVD29 during non-crop season (October 16 – March 15). Thirty-four supplemental low-flow groundwater wells would be installed.
  - Nonstructural components: Full utilization of the gate operation of the Steele Bayou water control structure to optimize fisheries exchange (75.0 feet NGVD29) as described in the current water control manual. Mandatory acquisition of residential and commercial properties up to 90 feet (101 structures); voluntary floodproofing and/or acquisition of properties up to 93 feet (231 structures). Voluntary acquisition of up to 11,816 acres of cleared land at or below the 2-year floodplain, and up to 27,675 acres of cleared lands between the 2-year and 5-year floodplains, through fee or a restrictive easement.
- **Alternative 3:** Structural and nonstructural alternative. This alternative modifies the dates of water level management under Alternative 2. Water levels would be managed at 90 feet NGVD29 during crop season (March 25 – October 15) and up to 93 feet NGVD29 during non-crop season (October 16 – March 24). The other structural and nonstructural components are the same as Alternative 2.

- **Alternative 4:** Nonstructural plan only. Acquisition or floodproofing of residential and commercial properties up to 98.2 feet. This includes voluntary acquisition of up to 1,845 structures and 137,926-acres of cleared lands.

Three Memoranda of Agreement between the USACE, the USFWS, and the EPA are being developed to address some environmental concerns regarding Alternatives 2 and 3.

- The first MOA is an agreement on the final water control operations which will require agreement by the Agencies for any deviations of the pump operation plan and water control structure operation plan envisioned by the proposed water management solution.
- The second MOA is a joint mitigation agreement designed to ensure the effective and timely development and review of the mitigation plan for each compensatory mitigation component. As part of this MOA, proposed work will not begin in waters of the United States until the mitigation plan for each compensatory mitigation component has been approved by the Agencies and all in-lieu fee program/mitigation bank credits have been purchased and/or compensatory mitigation sites have been secured.
- Finally, the third MOA is an agreement to collect and evaluate monitoring data across the YSA using field-based and satellite imagery approaches and to use this monitoring data to help inform adaptive management decisions regarding ongoing implementation of water management in the YSA.

The draft EIS identifies Alternatives 2 or 3 as the preferred alternative based on several concerns regarding Alternative 4. For example, actual participation rates in Alternative 4's voluntary acquisition program will not match the high rates necessary for the alternative to be effective and that low-income communities may not have the financial means to address the potential additional costs associated with relocations. Another concern is the conversion of such large amounts of land from agricultural production to conservation could adversely impact the local economy in the YSA by, for example, reducing the local tax base in the YSA and reducing jobs that are directly or indirectly related to agriculture.

Alternatives 2 and 3 include several changes designed to make those alternatives less environmentally damaging than previous pumping station proposals. These changes include incorporating higher pumping elevations and a seasonal approach to pump operation that will reduce impacts to wetlands and allow the floodgate at Steele Bayou to stay open longer than current practice to increase hydrologic exchange between the YSA and the Yazoo River and benefit fish and other aquatic wildlife. In addition, all wetland mitigation will be secured prior to any environmental impacts to ensure that this project would result in no estimated net losses of wetland functions. This means that any in-lieu fee program or mitigation bank credits relied on by the USACE would be purchased by the USACE prior to any environmental impacts and if the USACE pursues development of its own compensatory mitigation sites, those sites would be secured via conservation easement or fee-title acquisition prior to any environmental impacts.

Recommendations:

a) Including more complete information on the potential human and environmental impacts and benefits associated with each alternative. See below sections for specific recommendations.

b) Including additional information and analysis to help determine whether Alternative 4 is a practicable alternative that fulfills the overall project purposes.

c) Providing more clarity with respect to the type of nonstructural improvements that would be offered to property owners and landowners with each alternative (e.g., please clarify that each alternative would provide floodproofing).

II. Aquatic Resources

To ensure that impacts to wetlands, fish, and other aquatic organisms are thoroughly accounted for and effectively mitigated, the draft EIS evaluates impacts to these resources across the entire 5-year floodplain, a much larger area than the portion of the 2-year floodplain analyzed in previous proposals. However, the draft EIS has not yet fully evaluated the potential environmental impacts associated with each alternative.

The project would involve direct, secondary/indirect, and cumulative impacts to wetlands, fisheries, and other terrestrial and aquatic-dependent species. Direct and secondary/indirect impacts to wetlands and fisheries habitat were evaluated for both Alternatives 2 and 3; however direct and secondary/indirect impacts to all terrestrial and aquatic-dependent species were not evaluated for both alternatives, and the naming conventions among all analyses are inconsistent.

For Alternatives 2 and 3, the crop season start date only differs by nine days; however, the additional nine days provided in Alternative 3 are estimated to have substantial benefits to wetlands and fisheries, as demonstrated by the differences in functional losses and required mitigation to offset those losses. For example, the estimated wetland functional losses for Alternatives 2 and 3 are 34,687 and 25,470 Average Annual Functional Capacity Units, respectively. Additionally, the estimated impacts on fisheries for each alternative are 2,264 and 1,862 Habitat Units (Alternative 2 spawning and rearing) and 2,184 and 1,748 HUs (Alternative 3 spawning and rearing). Finally, when evaluating impacts to shorebirds, great blue heron, and wintering waterfowl; the alternative with the later crop season date (i.e. Alternative 3) was less damaging in all three cases. While the EPA notes that impacts to shorebirds and great blue heron were similar for both alternatives, the later crop season date resulted in 6,150 additional Duck Use Days for wintering waterfowl.

Bottomland Hardwood (BLH) wetlands and other aquatic resources in the YSA depend upon frequent saturation and inundation to provide critical ecosystem functions and services to humans, fish, and wildlife (Wharton et al. 1982[1], Dahl et al. 2009[2]). Yet this habitat has declined by more than 80%

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[1] Wharton et al. 1982 (USFWS): The Ecology of Bottomland Hardwood Forests of the Southeast: A Community Profile.

[2] Dahl, T.E., J. Swords and M. T. Bergeson. 2009. Wetland inventory of the Yazoo Backwater Area, Mississippi - Wetland status and potential changes based on an updated inventory using remotely sensed imagery. U.S. Fish and Wildlife Service, Division of Habitat and Resource Conservation, Washington, D.C. 30 p.

locally, primarily due to the large-scale conversion of fertile, frequently flooded land to agriculture since the late 1800s. While the project aims to provide flood risk reduction to communities in the YSA, it would simultaneously decrease the frequency and duration of flooding to aquatic resources, including BLH wetlands, which could result in significant cumulative impacts on the environment. However, the draft EIS has not yet evaluated the potential for cumulative aquatic resource impacts from Mississippi Rivers and Tributaries projects in the YSA to date, including how the proposed project would affect soil saturation in light of decreased backwater flooding.

The draft EIS also discusses the overall decline in stream baseflows and groundwater over time. This is largely caused by deforestation efforts, flood reduction improvements, and groundwater pumping associated with land use change in the YSA (Reinecke et al. 1988[3], Ouyang et al. 2021[4]) but can also be partly attributed to climate change patterns (Middleton and Souter 2016[5]). The extremely low stream baseflows, especially during already dry periods, have been dewatering mussel beds, reducing fish diversity, and impacting other sensitive environments within the Yazoo Basin (Killgore et al. 2024[6]). To supplement the existing river flows, 34 low-flow groundwater wells within 30,000 feet of the Mississippi River channel and upstream of the YSA are being proposed to help address ecological issues associated with periods of low stream flows such as standing stock and production for many fish species and support aquatic resources in the YSA.

Recommendations:

a) Only three of the seven terrestrial wildlife and waterfowl analyses evaluated both Alternatives 2 and 3 (Appendix F-4). To adequately review the potential environmental impacts for each alternative all analyses should evaluate losses associated with both Alternatives 2 and 3.

b) Using consistent naming conventions for all alternatives evaluated for improved clarity throughout the final EIS and appendices. Failing to do so could lead to confusion regarding which structural alternative is least impactful. For example, Appendices H (Water Quality) and F-6 (Aquatic Resources and Fisheries) reverse the definitions for Alternatives 2 and 3. Furthermore, all the species-specific assessments within Appendix F-4 (Terrestrial Wildlife) and Appendix F-5 (Waterfowl) refer to Alternatives 1 and 2 as the structural alternatives, and of these, they are not consistently defined. Only Appendix F-3 (Wetlands) correctly defines each alternative and includes results consistent with those naming conventions.

c) The sentence on page 5 of Appendix F-6 could cause confusion related to the area assessed for the fisheries impact assessment. It incorrectly states *"For this application, only agriculture and bottomland hardwood cover types within the 2-year flood frequency were considered."* Clarifying

[3] Reinecke, K. J., Barkley, R. C., & Baxter, C. K. (1988). Potential effects of changing water conditions on mallards wintering in the Mississippi Alluvial Valley. Pages. 325–337 in and MW Weller, editor. Waterfowl in winter.

[4] Ouyang, Y., Jin, W., Leininger, T. D., Feng, G., & Yang, J. (2021). Impacts of afforestation on groundwater resource: a case study for Upper Yazoo River watershed, Mississippi, USA. Hydrological Sciences Journal, 66(3), 464–473. https://doi.org/10.1080/02626667.2021.1876235

[5] Middleton, B. A., & Souter, N. J. (2016). Functional integrity of freshwater forested wetlands, hydrologic alteration, and climate change. Ecosystem Health and Sustainability, 2(1). https://doi.org/10.1002/ehs2.1200

[6] Killgore KJ, Hoover JJ, Miranda LE, Slack WT, Johnson DR and Douglas NH. 2024. Fish conservation in streams of the agrarian Mississippi Alluvial Valley: conceptual model, management actions, and field verification. Front. Freshw. Sci. 2:1365691. doi: 10.3389/ffwsc.2024.1365691

this sentence in Appendix F-6 to indicate that all potential fisheries habitat was evaluated within the 5-year floodplain and not only the 2-year floodplain.

d) Including Appendix D-2 (Fish and Wildlife Coordination Act Report) and Appendix G (Threatened and Endangered Species) in the final EIS. Those appendixes have not yet been released for public review and comment.

e) Including a more thorough analysis of cumulative effects on aquatic resources in the YSA. A short narrative already exists in the 404(b)(1) analysis; however, a more quantitative analysis of the impacts of the MR&T project, as well as agricultural practices, in the YSA is recommended to provide a more comprehensive assessment of cumulative effects. Additionally, while the current draft articulates potential effects of wetland dewatering from FESM-based inundation estimates, the final EIS should address how the alternatives will affect soil saturation in light of decreased backwater flooding.

f) Providing information to ascertain potential water quality impacts locally and downstream, which could subsequently affect fisheries habitat and recreational opportunities. See below sections for more specific recommendations.

g) Further describing how supplemental low flow wells will be an effective watershed component of Alternatives 2 and 3 including results from any pilot projects and any other current information to demonstrate potential effectiveness.

h) Providing clarification to Appendix F-3 (Wetlands):

- The text describing Table 1 and the inundation and saturation (page 12), e.g., "... *areas estimated to flood less than 7 days based on inundation model results exhibited an average of 88 days of soil saturation over an 8-year period; study locations estimated to have 7-14 day flood inundation exhibited an average of 151 days of saturation; and areas with modeled flood inundation durations >14 days exhibited an average soil saturation period of 172 days (Table 1)* ..." does not suggest the influence of precipitation as claimed (e.g., the text states "... *they do suggest that precipitation plays an important role in wetland hydrology, and some areas retain wetland characteristics of soil saturation regardless of (or in addition to) backwater flooding-related hydrological events*"). Instead, this supports the idea that the soil saturation data does not align with the modeled flood inundation durations (sourced from the Flood Event Simulation Model) which, given the simplification of the Geographic Information System-based FESM may be incorrect or misleading. Please temper the language asserting the dominant sources of hydrology and including a more thorough discussion of how estimated modeling error might complicate interpretation of flood frequency and duration in the YSA.

- The text conflates inundation with saturation, please clarify the terminology used throughout the document to correctly represent whether conclusions are based on estimates of inundation or saturation. Inundation occurs when saturated soils produce visible surface water whereas soil saturation refers to how much water is contained within pore spaces of the soil. As the USACE wetland delineation manual notes, wetlands include areas that are saturated within 12 inches of the soil surface, and changing the surface-water inundation frequency will also likely affect the frequency of soil saturation within 12 inches of the surface.

- There appear to be nearly two pages of missing text on pages 17-19 making review of Appendix F-3 incomplete. Missing text should be included in the final EIS.
- The Appendix relies on National Agricultural Statistics Service data to derive estimates of the extent of wetlands in the YSA. Because NASS data is obtained during the summer, seasonal changes to inundation patterns can affect interpretation of existing land use. Specifically, certain areas designated as open water during high precipitation years may be identified as wetlands during years with more average precipitation levels, which could potentially result in some unidentified wetland functional impacts. The Appendix should include titles and dates of sources used, using citations to publicly available data where possible, and ensure that information referenced can be made available in the final EIS or on the project website if it is not publicly available elsewhere (e.g., inundation maps of the post-project floodplain, data used in NASS assessments, etc.).
- The FESM is referenced (thesis/dissertation link provided) but model input values and uncertainties of the GIS model are not considered (page 28), preventing full appreciation of the applicability of the FESM (as well as repeatability by stakeholders and collaborators). See recommendations within Section III, below, for concerns and recommendations relating to the use of the FESM GIS model.
- Percent and days of the year appear to be incorrect (page 28). For instance, 2.5% of the year corresponds to 365x0.025 = 9.125 days, while it is written as <9 days. These values should be corrected in the final EIS.
- It is unclear if the inundation periods were applied "during the growing season" (page 29). Elsewhere in the draft EIS, it was determined that the YSA had a year-round growing season as the soil temperatures were always >5C. Therefore, the inundation period (and saturation) would be 14 consecutive days during the year, not "during the growing season". The final EIS should clarify if these were the 'modeled' inundation periods exploring periods of consecutive inundation (ignoring saturation) such as 14 days during a year (14 consecutive days during a given year of 365 days) or if they were calculated as during a growing season. If it is now a yearly analysis, the use of the term "growing season" should be removed after introducing that the growing season is year-round.

III. Hydrologic, Hydraulic, and Water Extent and Duration Analyses

Hydrologic, hydraulic, and water extent and duration analyses are critical to support the factual determinations of the EIS. Appendix A (Engineering Report) details data, model setup, model results, and subsequent project design, in the context of hydraulic and hydrologic models for the study area. The models were built using Hydrologic Engineering Center-Hydrologic Modeling System and HEC-River Analysis System frameworks. Models used input data in the forms of terrain/elevation, stream channel geometry, roughness, streamflow, precipitation, and temperature conditions. Models were calibrated for four events and validated for four other events at three locations in the study area. The hydrologic model was calibrated for river stage and the estimated flows from HEC-RAS were used as inputs into the hydraulic 2-D model which was then used to compare the effects of pumping on river stage.

The hydrologic and hydraulic models appear to be able to assess impacts of flood events and flood control measures on inundation in the study area. However, it is not clear that the models are adequately capturing the duration of the flood events, which may be concerning for effective planning to manage flood events that persist for longer than a few days. Goodness of fit measures were used for HEC-HMS models, yet no metrics were provided for HEC-RAS calibration and validation models. Instead, the USACE relies on visual comparisons of those calibration and validation years (figures 2-58 through 2-75). Additionally, for replicability of the modeling work, alternative input datasets (like precipitation data) may benefit the project. Finally, adjustments to the presentation of the models can improve clarity. See the recommendations below for specific ways in which clarifications are needed within Appendix A.

While Appendix A includes a thorough explanation of the USACE methodologies using HEC-HMS and HEC-RAS to simulate past flooding events and impacts on stage water levels due to the future pumps, once those stage water levels are then taken as input into the FESM model, the methods used to convert the stage levels into flooding extents and duration of extent are not clear. Within the recommendations, the EPA highlights several aspects of the FESM methodology that need to be added to ensure clarity and repeatability of the GIS analysis as it is the basis for the wildlife and wetland impact assessments.

General Recommendations:

a) FESM methods and assumptions should be clearly explained, using citations and data to clearly document results. The final EIS should identify and state all assumptions, more clearly identify specific inputs, state parameters used in the model (for instance, what slope correction value was used), identify validation steps used to ensure that the model provides accurate information (including estimates of vertical error for DEMs and impacts on the modeling outputs), and provide results of the model. While more complex than running GIS-based FESM, if FESM methodologies cannot be more clearly articulated and validated, the USACE has the potential capability to use their existing and well-cited HEC-HMS models to produce flooding extents and duration for years that approximate the 5-year floodplain.
b) Additionally, several components of the sections regarding the methodologies used to assess impacts of pumping to wildlife and wetland flooding frequency and duration should provide more information. Apart from additional clarity, it is important that output results of extent and duration for the 90 ft and 93 ft extent for the different alternatives be included, spatially showing where duration and frequency zones are found and where changes occur between the alternatives. These maps provide the spatial foundation for many of the calculated impacts including the Wetland Appendix Tables 53-91 and should be included in the final EIS.

Recommendations related to the use of HEC-HMS and HEC-RAS from Appendix A:

a) The final EIS should represent elevation data in terms of a consistent datum. There is an online tool from the National Oceanic and Atmospheric Administration (https://geodesy.noaa.gov/NCAT/) that converts between NGVD 29 and NAVD 88.
b) Figure and table numbers throughout the document should be corrected for accuracy and flow/order with the text. Many figure numbers are difficult to follow. For example, "Figure 2" is cited in the text multiple times and should be clarified which is which in the text. For instance, the line beginning with "In addition, the northern..." (Paragraph 25) has Figure 2 referenced but it should be clarified as Figure 2-4.

c) Many figures, including maps, are not legible or are difficult to read and interpret. For example, Figure 2-25 is not rendered such that details and labels can be discerned.

d) There are opportunities to include more maps that clarify information about the YSA. For example, it would be beneficial for the reader to have a reference map of the overall study area that includes locations of existing water control structures, calibration locations, proposed pumps and low-flow wells, inlet and outlet channels, and all different rivers and channels. Figure 2-5 is beneficial; however, it could be improved with additional GIS layers for reference.

e) Plots and tables should have adequate and clear information for the reader. For example: Figure 2-53 should have axis labels to better orient the reader to the data.

f) Lake Okeechobee is called both the largest natural and largest man-made lake (Paragraph 19). It is the former (outside of the Great Lakes), but significantly modified by levees. This should be clarified by removing it from examples of "man-made reservoirs".

g) Wikipedia isn't a peer-reviewed source (Paragraph 19). The YSA is not a lake or a reservoir but a system of agricultural, urban, and natural lands. These should be corrected.

h) Rather than using National Centers for Environmental Information data (Paragraph 22) for precipitation and then interpolating spatiotemporally, it would be more straightforward to use a radar-based, quality-controlled meteorological dataset like NLDAS (https://ldas.gsfc.nasa.gov/nldas).

i) Figure 2-4 should say "Mississippi Climate Division 4 – Lower Delta" to clarify.

j) The Appendix states *"Observed data on the Big Sunflower River at Sunflower, Mississippi, show that annual runoffs vary from about six to 41 inches and average about 24.5 inches over the drainage area"* (Paragraph 27). This section should identify how runoff data were "observed".

k) Appendix F-3 indicates that headwater floods typically have >1' slope between gages (Paragraph 28), while backwater floods occur only when the downstream river experiences high stages (without noting a "typical height" such as 1'). The Appendix should identify if 'headwater flood' requires a higher gage height upstream or, conversely, if a backwater flood requires a >1' slope between the downstream and upstream gage (noting the level of specificity is "a >1' slope"). The Appendix should clarify this in regard to "a true backwater flood" which has a "flat or nearly flat surface" and the period of time for a flat or nearly flat surface to emerge. The slope in the study area (Paragraph 21) is noted to be 0.3 to 0.9 feet per mile (suggesting the entirety of the basin has ~>1' slope between gages).

l) Backwater floods were elsewhere defined as "downstream river experiences higher stages than the tributary" and "a flat or nearly flat surface". A third definition is introduced (Paragraph 29) when (specifically) the Steele Bayou flood control structure riverside water height exceeds that of the landside, given that the landside is above 80.0' (NGVD29). That causes the gates to close preventing outflow. The flow would continue but build up and spread, with inundation occurring. Headwater floods may be assumed here to be flat or nearly flat, too, considering the landscape topography. The backwater flood should be clearly defined.

m) In Figures 2-11 and 2-12 the calibration plots for the 1991 flood event indicate that the model does not capture the multiple-day duration of the May flood event, instead representing it as a shorter-duration peak in flow that quickly decreases to previous levels. The same result is seen in Figure 2-14. Because the duration is a key component of a flood event, it is integral that the models can capture this. It appears this issue is not translated to the HEC-RAS model results, so it may not require additional HEC-HMS calibration. Additional context should be provided to explain why the model not capturing the 1991 and 2019 flood event durations is not a major concern for the project.

n) A citation should be provided for the very good to unsatisfactory rating of the Nash-Sutcliffe Efficiency metrics (Paragraph 101).

o) The Appendix should clarify if the improved or original HEC-HMS model was used (with the "unsatisfactory" performance for Steele Bayou at Grace (Paragraph 110 and Paragraph 136)).

p) The Appendix should identify the vertical error associated with the 3-m LIDAR data (P119). This error is manifestly different in forested lands (e.g., BLHs) than in flat agricultural lands and paved urban landscapes, which should also be addressed (e.g., how this systematic vertical error affects the inundation elevations in the alternatives). Failing to account for this error when moving water on a low-slope area like the YSA subjects the results to significant potential error. The slope in the study area (Paragraph 21) is noted to be 0.3 to 0.9 feet per mile.

q) The Appendix should identify the actual goodness of fit metrics (calibration and validation) that provide estimates (Paragraph 141) and whether the calibration was satisfactory or not. *"The results from the verification runs show similar discrepancies to those that were identified from the calibration runs. However, validation was considered to be appropriate because the results at Steele Bayou and Little Sunflower showed the same level of accuracy as the calibration runs."*

r) Only two parameters were analyzed for impacts on results (sensitivity), Manning's n values and precipitation (Paragraph 143). The model has numerous other sources of uncertainty and error (e.g., topography and vertical elevation error, ET error, model parameterization decisions, model structures, errors inherent in process-based models trying to represent an area as large as the YSA, etc. – and the runoff model used is more prone to affecting the outcomes than the input precipitation data). These results do not "prove that precipitation was the driving force behind the uncertainty" but that it was more impactful than Manning's n values. The precipitation data may be amongst the most robust data used in the analyses.

s) The dates for "turning on" and "turning off" the pumps should be specified (Paragraph 145) in addition to the data for "pump-on" operations in the figures.

t) Table 2-21 does not support the statement (Paragraph 146), *"It is important to note..."*. The difference between observed gage and modeled elevation is as follows: 1997 +0.3 model, 2009 +0.2 observed, 2019 +0.3 model, 2020 +0.1 model. RAS model runs were 0.2-0.3' higher in three of four runs, and 0.2 feet lower than the observed in one of four runs. Table 2-21 should be corrected.

u) While Figures 2-106 to 2-109 show the influence of the pump on extent, there are no similar figures for Alternative 3. There are no maps to accompany Table 2-29 and show the results of the difference in growing season. To compare the effects of different alternatives, maps representing the model results for Alternative 3 should be added here.

v) More information is needed to evaluate potential increases to flooding downstream (Paragraph 158). Although the Appendix provides relevant information on this page, it should also provide information like the hydrologic and hydraulic analysis that was reported in November 2019 but updated to reflect the currently proposed alternatives.

<u>Recommendations related to wildlife and wetland impacts and FESM methodology in Appendix A:</u>

a) Overall, FESM methods and assumptions should be clearly explained, using citations and data to clearly document results. Information that is the same as presented in previous iterations of the project could be referenced by citation. Other new information needs to be clearly explained in the final EIS.

b) Identify the vertical error for the Digital Elevation Model and inundation tools used, as areas are being determined for as small as 8" of vertical change (Paragraph 166). Spreadsheets are referenced but do not appear to be available or linked within the draft EIS. These should be made available in the final EIS.

c) It is unclear what is meant by the five wetland profiles (Paragraph 167-169). An example map of those profiles should be provided.

d) The paragraph ending with *"The FSEIS examined all potential wetland areas within the 5-year floodplain subject to flood inundation."* appears to be incomplete (Paragraph 169). Please clarify whether referring to this draft EIS or if referring to the 2007 final supplemental EIS. Please also identify if this indicates (as was also stated in the Wetland Appendix) that all potential land covers both natural lands and agriculture within the 5-year floodplain were examined as potential wetlands, or if this project examined all potential wetlands within the 5-year floodplain subject to flood inundation and treats all those areas as potentially impacted wetlands.

e) Wetland mapping is unclear as a stand-alone section in this document (Paragraph 170). The Appendix should identify what gages were used and where and at a minimum refer back to other tables and figures that describe the gages and their locations. It should also identify what water surface elevations were used and how were they determined. This can be assumed from the HEC-RAS modeling, but it should be stated explicitly, including what lines are being junctioned and which DEM is used and its provenance (and vertical error).

f) While Paragraph 170 attempts to include raster output details, they are confusing. It should identify values and which alternatives were "run" specifically, how wetland zone maps were combined and their programs and resolution. This section could also incorporate the No Action Alternative and Alternatives 2 and 3 wetland zones and composite wetland maps resulting from FESM analysis spatially showing where duration and frequency zones are found and where changes occur between the alternatives. Information that is the same as presented in previous iterations of the project should be referenced by citation, including that for the model and the overall methodology.

g) A table indicating the surface stages for the five flooding frequencies and five duration intervals should be provided for the base year and alternatives so that the model could be reproduced (Paragraph 170).

h) Two files or worksheets are referenced in Paragraph 170 but are not linked or appear unavailable. "The results of the queries of all maps are provided in the "NASS22_SepWetlands.xlsx" file. The notes worksheet has a matrix of the possible grid-cell values." The inclusion of both a table with input parameters, and maps of results may be included in these documents but are not available within the draft EIS. These should be made available in the final EIS.

i) Paragraph 182 references a verbatim section that should be clarified.

IV. Water Quality

The proposed project involves the discharge of dredged or fill material into waters of the United States. 40 CFR 230.10(c) specifies that no such discharge of dredged or fill material shall be permitted if it causes or contributes to violation of any applicable state water quality standards. CWA Sections 101(a) and 303(c) specify that State water quality standards should provide water quality that protects public water supplies, aquatic life, wildlife, recreation in and on the water including water supply uses (40 CFR Part 131.10(a)). Water quality standards are made up of waterbody uses and criteria. Aside from environmental impacts caused by altered inundation patterns, the project could potentially impact water quality and contribute to significant degradation of the aquatic environment. The draft EIS did not fully evaluate downstream impacts associated with each alternative. Downstream impacts may include altered flow rates, altered nutrient and sedimentation deposition patterns, changes to water temperature and salinity downstream, and changes to biogeochemical cycling – all of which can have subsequent impacts on the aquatic environment.

General Recommendations:

a) Providing a more robust writeup and discussion to address all applicable water quality criteria that apply in the project area.
b) Providing additional qualitative and quantitative information to address the specific feedback listed below.
c) Providing a water quality model to generate more quantitative conclusions on the impacts, both inside the levee gates within the primary receiving waters and downstream of the project area.

Recommendations related to Water Quality Criteria:

a) Section 4.2.2.8.2 of the main draft EIS document refers to the EPA's recommended criteria for dissolved oxygen (DO), but it is applicable to refer to Mississippi's water quality criteria for DO, and any other relevant criteria related to impacts associated with the proposed alternatives. The USACE should collaborate with the Mississippi Department of Environmental Quality to ensure all applicable parameters (and associated water quality criteria) are covered accurately. For example, the DO discussion should reflect the applicable state DO criteria which is that DO *"shall be maintained at a daily average of not less than 5.0 mg/l with an instantaneous minimum of not less than 4.0 mg/l."*

b) It would be appropriate to include a reference to the applicable free from narrative to support additional discussion of nutrient concentrations. A(3) in Mississippi's Rule 2.2. says in part, "*Waters shall be free from materials attributable to municipal, industrial, agricultural, or other discharges producing color, odor, taste, total suspended or dissolved solids, sediment, turbidity, or other conditions in such degree as to create a nuisance, render the waters injurious to public health, recreation, or to aquatic life and wildlife, or adversely affect the palatability of fish, aesthetic quality, or impair the waters for any designated use.*" While the EPA is aware that the addition of the pump system is expected to improve water quality concentrations for various parameters, it is also widely understood that the system is limited in its ability to completely attain the water quality criteria at all times due to the modified landscape in combination with naturally occurring conditions. A better quantification of the improvements identified in the alternatives and how they compare to Mississippi's relevant water quality criteria could be determined with a Water Quality Model.

c) Coordinate with Mississippi water quality standards staff to determine whether different criteria than above should apply to certain waterbodies, such as those for ephemeral streams, which have different criterion for DO and certain other parameters. Additionally, the State recently adopted additional designated uses for Drainage Waters and for Modified Fish and Wildlife, which in the future may be more appropriate designated uses for waterbodies in the project area. While adoption of new designated use(s) and criteria would not be feasible in the near term, discussion with water quality standards staff in Mississippi can best inform what should be considered now and in the future.

d) It should be noted that with respect to CWA 401 water quality certification, Federal agencies can coordinate early and often with neighboring jurisdictions downstream of the proposed discharge. It is important to understand that the certifying authority's certification (in this case Mississippi) decision itself may or may not be the right venue to address those issues of a downstream neighboring jurisdiction's issue (i.e., Louisiana). The certifying authority (MSDEQ) is only certifying Mississippi water quality requirements and not another (Louisiana) jurisdiction. Please note that if the state of Mississippi either waives or certifies the water quality certification, the USACE must notify the EPA Region 4 within 5 days. The EPA would then have 30 days to consider "may affect" the water quality requirements of Louisiana and so notify the state. Louisiana would then have 60 days to determine whether the discharge will violate its water quality requirements.

Recommendations related to Qualitative and Quantitative Information:

a) Most of the quantitative information is generally focused on what will take place in the near field, within the basin. While there is discussion of settling out of suspended solids and potential for less decrease in DO values if water levels are reduced, there is not enough quantified discussion of the downstream impacts of the increased volume of water that will be pumped downstream as part of Alternatives 2 and 3. For example, Section 5.2.8 notes that Alternative 2 "is not anticipated to increase the total loading of [total phosphorous] and [total nitrogen] to the Mississippi River." Additional discussion and quantification of the potential difference in timing and volume relative to a no pump scenario when structures are opened versus the timing and volume associated with Alternatives 2 and 3 would be useful to expand on any potential for downstream impacts.

b) The nutrient information summarized in Section 4.2.2.8.1, notes the concentrations in the Yazoo are lower than those in Midwest Tributaries, below the National Median Concentrations published by the U.S. Geological Survey, and "does not contribute a disproportionate load of nitrogen to the Gulf of Mexico and is generally in line with its proportionate contribution of phosphorus to the Gulf of Mexico." The section also highlights the seasonal cycle of higher to lower nutrient concentration values from early in the year to later in the year before discussing the generalized reductions tied to best management practices efforts over time in the basin. The final EIS should identify how the Yazoo basin specific nutrient levels relate to the potential to cause or contribute to any impact(s) on response variables such as chlorophyll production or diurnal DO swings. Since there are currently no numeric nutrient criteria applicable to this part of the State, the final EIS should identify how the nutrient levels compare to available Mississippi water quality specific guidelines for protection of the water quality criteria for nutrients.

c) DO information in Section 4.2.2.8.2 summarizes how lower levels, exacerbated by higher temperatures and lower flows, "impose a severe impact on the overall health of the aquatic ecosystem" and Paragraph 39 in Appendix H (Water Quality) indicates the pumps "will help increase DO in the water column by minimizing the overall depth of a flood event and improving diffusion from the surface water of the interior backwater." These expectations are supported by observations from multiple-depth DO sampling plots (Figures 2-7 to 2-10), with notes that photosynthesis explains some periods of elevated DO when looked at within a day, and water depth plots against DO concentrations (Figures 2-5 and 2-6). However, additional data that can quantify the expected level of improvement in DO with the operation of the pump in Alternatives 2 and 3 would be beneficial. Additional quantification of any potential impacts resulting from releases of low DO water, over a shorter duration and higher volume, on downstream waters, should also be included in the comparison of alternatives.

d) Regarding turbidity, the draft EIS notes that stagnation creates the conditions where suspended solids can settle out of the water column. Section 5.2.8 states that *"sediment disturbances during construction of the Yazoo Backwater Pump may cause temporary increases in turbidity."* The final EIS should identify if turbidity associated with erosion is best addressed (and is it expected to be addressed further in the future) through BMPs to minimize sediment availability at the various flooding levels.

e) The draft EIS explains that the operational plan for supplemental low flow groundwater wells is intended to help during critical low flow periods, is not available for irrigation "which would hamper the overall benefits to the project," and represents the goal to "establish [base flows] for the region which will mimic flows observed in the mid-20th century in the Yazoo basin." Paragraph 81 in Appendix H further elaborates that the additional flows will supplement existing flows to a rate of 0.1 to 0.2-cfs per square mile for the applicable watersheds. Additional discussion on the rationale for the selection of these endpoints, including any critical assumptions made, to support the conclusion that operation in this manner will "support year-round channel geomorphology conditions, provide the necessary water quality conditions for aquatic life, and maintain adequate inundation for mussel beds" would be useful to include in the final EIS. The expectation to not operate the wells during major flood events and the general discussion regarding monitoring and management of the wells post-construction with adaptive management will be important if one of these alternatives is selected for implementation.

Recommendations related to the Water Quality Model:

a) Correcting the dates listed for Alternatives 2 and 3 on page 8 of Appendix H.

b) Page 12 of Appendix H indicates that the most recent iteration of the third Mississippi and Atchafalaya River Basins SPARROW model "is believed to corroborate the premise that the Yazoo Basin is not a disproportionate contributor to the nutrient loading of the Gulf Hypoxic Zone." Please provide a citation for this statement.

c) Discussion of potential water quality impacts would be improved with quantitative support from an updated water quality model. Review of previous documents on the project indicate that a Water Quality Analysis Simulation Program model was developed in support of the 2007 report, and it may be beneficial to update that model in order to increase support for statements made in Appendix H. Alternatively, providing additional details on development of the MARB SPARROW model can increase confidence in inferences from it in the event of not incorporating a larger water quality model.

d) Expanding discussion of Figures 2-15 and 2-16 in Appendix H to fully discuss yellow shaded time periods shown in these figures.

e) Section 5.2.1 of the draft EIS states "*water quality could improve as well as a reduction in the amount of sediment carried into streams*" via existing programs (Conservation Reserve Program and Wetland Reserve Program). The final EIS should identify if these reductions will continue to occur if other alternatives are selected.

V. Environmental Justice (EJ)

Executive Order 12898 *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, dated February 11, 1994, was supplemented by EO 14096, *Revitalizing Our Nation's Commitment to Environmental Justice for All*, dated April 26, 2023. EO 14096 directs federal agencies, as appropriate and consistent with applicable law to identify, analyze, and address disproportionate and adverse human health and environmental effects (including risks) and hazards of federal activities, including those related to climate change and cumulative impacts of environmental and other burdens on communities with environmental justice concerns. Section 3 (b)(i) of EO 14096 also directs the EPA to assess whether each agency analyzes and avoids or mitigates disproportionate human health and environmental effects on communities with EJ concerns when carrying out the EPA's commenting_responsibilities under CAA Section 309. The draft EIS includes a discussion of affected communities with EJ concerns and environmental consequences. However, several direct, indirect, and cumulative impacts that may affect communities with EJ concerns in the study area and downstream are not fully discussed. Please include additional information in the final EIS to better understand direct, indirect, and cumulative impacts to communities with EJ concerns caused by the project and identify measures to avoid or mitigate any resulting disproportionate and adverse effects.

EO 14096, section (3)(a)(vii) highlights the need to "*provide opportunities for the meaningful engagement of persons and communities with environmental justice concerns who are potentially affected by federal activities including by providing timely opportunities for members of the public to share information or concerns and participate in decision-making processes, fully considering public input provided as part of decision-making processes... provid[ing] information on a federal activity in a manner that provides meaningful access to individuals with limited English proficiency and is accessible to individuals with disabilities, and providing notice of and engaging in outreach to communities or groups of people who are potentially affected and who are not regular participants in federal decision-making.*"

Recommendations on EJ Analyses:

a) The final EIS should include information about persons with disabilities and individuals with limited English proficiency that may be affected by the project in Section 4.2.1.2. According to the EPA's EJ mapping and screening tool, EJScreen 2.3, there is a census block group in Sharkey County that is in the 92nd percentile for the state for limited English population, indicating it has a greater proportion of people who do not speak English than other parts of the state. EJScreen data further reveals that 100% of the limited English population in the county speak Spanish.

b) The final EIS should describe how the positive impact of the proposed action to agriculture production will benefit communities with EJ concerns. The final EIS analysis of agricultural and farm job benefits to communities with EJ concerns should describe who was affected by historical farm job loss in the study area and the reason for the loss of farm jobs (flooding, new technology, farm owners reduced workforce, etc.) and describe the number of farm jobs that will become available to residents from communities with EJ concerns due to the reduction in crop inundation that may benefit the agriculture industry as a result of this project. The final EIS also should identify, analyze, and address barriers that could impair the ability of communities with EJ concerns to receive equitable access to human health or environmental benefits from the project in accordance with section 3.a.iv. of EO 14096.

c) In the final EIS, describe existing health, environmental and social burdens (baseline conditions), as well as those caused by climate change, in the communities with EJ concerns affected by the project and whether the project may exacerbate existing burdens or result in additional indirect, direct, and cumulative impacts to communities with EJ concerns due to existing and foreseeable conditions.

d) Including information on indicators from Council on Environmental Quality's Climate and Economic Justice Screening Tool used to identify disadvantaged communities, which includes information on climate change, health, energy, housing, transportation, waste and wastewater, legacy pollution, workforce development burdens. Please use EJScreen to understand, in greater detail and at a smaller scale, potential EJ concerns. The tool provides information on environmental burden and socioeconomic indicators as well as pollution sources, health disparities, critical service gaps, and climate change. The data is displayed in color-coded maps and standard data reports which feature how a selected location compares to the rest of the nation and state.

e) Identifying, analyzing, and addressing historical inequities, systemic barriers or actions related to federal regulations, policies, or practices that have influenced existing conditions by impairing the ability of communities with EJ concerns in the study area and downstream of the project to achieve or maintain a healthy and sustainable environment. Include any information related to the history of poverty, racial discrimination, and legacy pollution in the area that has affected where populations live in the study area, their exposure to environmental pollution and hazards, and their baseline health conditions and social vulnerability.

f) Explicitly describing any cumulative impacts identified that may affect communities with EJ concerns for each alternative and whether they will have disproportionate and adverse effects. The cumulative impact analysis should consider baseline conditions in communities, past and reasonably foreseeable future projects, and ongoing and projected climate change.

g) When discussing the impacts of the no action alternative in communities with EJ concerns, the draft EIS states that *"flooding has caused undue hardships and economic losses to residents of the area due to flooding of homes, disruption of sanitation facilities, lines of communications, and transportation and subsistence fishing"* (page 106). The final EIS should describe under each alternative how non-residential structures, such as sanitation facilities, roads, communication lines, will be impacted under each alternative and not just the no action alternative and whether and how the action alternatives will contribute to or minimize any disproportionate and adverse effects to communities with EJ concerns. For example, the final EIS should include information on the number of roads that may be flooded or not flooded at different flood levels (90 ft, 90 ft to 93 ft) as a result of the project, describe any impacts to community cohesion, such as relocation of businesses or other non-residential structures utilized by local communities, and critical infrastructure such as sanitation facilities, communication lines, schools, and health care facilities.

h) The draft EIS states that there will be both direct benefits to communities with EJ concerns communities in the form of increased opportunities for hunting and fishing but does not include information on how community members currently utilize these resources. The final EIS should describe how community members currently utilize these resources to demonstrate the benefit of the expansion of hunting and fishing opportunities.

i) Table 5-1 identifies structures that will be affected by mandatory buyout, voluntary buyout, and flood risk mitigation as a result of the pumps, and which of these structures lie in disadvantaged communities. However, the table does not specify how many structures in each category are residential structures (though some information about residential structures facing buyouts is explained in the text). The majority of structures eligible for voluntary or mandatory relocations are located in disadvantaged census tracts (52 of 55 residential structures in the 90-foot level of inundation and 80 of 95 residential structures in the 90-93-foot inundation level (page 106)). The Final EIS should include a detailed analysis, consistent with the recommendations below, of the potential impacts of the proposed mandatory and voluntary relocations and alternative mitigation measures that do not involve relocation. The final EIS should also describe in detail the proposed mitigation measures to address relocation.

j) The draft EIS states that there will be mandatory buyouts of 52 residential structures and voluntary buyouts of 80 residential structures within disadvantaged communities. The section that discusses the Uniform Relocation Act requirements~~,~~ states that owner occupants and tenants will be eligible to receive relocation benefits and advisory services, and that detailed information on this plan will be developed during the design phase of the project which is not subject to public notice and comment. A full disclosure of possible benefits should be provided in the final EIS to provide opportunities for the public to review and provide comments.

k) Reduction of flood potential for the homes of those eligible for relocation is listed as a benefit of the project for disadvantaged communities, but the draft EIS does not demonstrate that there are homes outside of any floodplain that are of similar value to the homes being bought out. The draft EIS also does not discuss or address impacts on communities caused by relocation, such as changes in access to work, school, places of community gathering, and access to a customer base for business owners and does not describe whether this will cause a disproportionate impact. A housing market analysis should be completed, including available housing stock, average pricing, school availability, and proximity of houses to each other and the current employers of the community members in the study area, and be included in the final EIS.

l) The final EIS should update Table 5-1 to clarify the number of residential structures in each category, clearly stating the proportion of residential structures that will benefit from pump flood risk mitigation that are in disadvantaged communities.

m) The final EIS should describe the relocation benefits to commercial property owners and tenants, paying close attention to small and medium sized businesses.

n) The final EIS should discuss the benefits and adverse impacts of mandatory and voluntary relocation and mitigation measures and address unavoidable impacts. The final EIS should disclose mitigation options required by the Uniform Relocation Assistance Act and Real Property Acquisition Policies Act. The final EIS should also disclose and consider any additional measures beyond the requirements in the beforementioned acts that would ensure a broad range of relocation benefits reach affected communities with EJ concerns. When identifying and adopting appropriate relocation mitigation measures, the final EIS should consider possible inequities and systemic barriers, that may be borne by the communities in the project area, such as red lining and financial discrimination, that have impacted their opportunities for property ownership, access to housing, and starting a business in accordance with the directives in Section 3.a.iii of EO 14096.

o) Additional mitigation measures include but are not limited to: Advisory services and related support before, during and after relocation, available in multiple languages; Develop and implement a targeted engagement plan that is accessible for persons with disabilities and limited English proficiency to educate qualified individuals how to apply for voluntary relocation benefits; Providing an outreach coordinator that could assist community members through the mandatory and voluntary relocation process with the utilization of the benefits provided by law. The coordinator could partner with trusted community organizations such as faith-based organizations, nonprofits, and others, for assistance with the outreach.

p) Including additional information on downstream impacts and identify whether there are any disproportionate and adverse effects from the project on communities with EJ concerns downstream of the study area. Describe the demographics and socioeconomic characteristics of populations in the downstream area in the affected environment section (Section 4.2.1.2), any existing health, environmental and social burdens, and how downstream flooding of structures and roads may directly, indirectly, or cumulatively impact these communities with the projected downstream flood levels that may result from the project.

q) Discuss whether any modeling indicates downstream flooding will exceed the extent of the 2011 flood and how this will affect structures that remain in the area, both within the past flood extent and any areas outside of the 2011 flood extent. The final EIS should describe any limitations of the modeling presented on page 110, how the ongoing and reasonably foreseeable effects of climate change and future development patterns may affect the Mississippi River modeling and projected flood extent, and any resulting impacts to communities.

r) A third-party expert consultant challenged the integrity of the model used to assess the downstream impacts of the pumps, arguing that it underestimates the resulting potential increase in downstream flooding (specifically, the impacts in the majority Black neighborhood on the north side of Vicksburg). The final EIS should provide an explanation to this analysis in the Engineering Appendix.

s) For any disproportionate and adverse impacts identified by the final EIS, the final EIS should disclose and adopt mitigation measures, developed with community input as appropriate, consistent with EO 14096 Section 3(a)(i).

Recommendations on Meaningful Engagement:

a) The final EIS should disclose in more detail the public engagement conducted for the project, including information on outreach methods, attendance at meetings and efforts to accommodate barriers such as providing meetings in locations near communities with EJ concerns, information in simple and easy to understand language, materials in languages other than English, virtual meetings, and use of non-virtual participation in areas with limited broadband access.

b) The final EIS should clearly identify and describe preferences and concerns for proposed alternatives and mitigation measures from communities with EJ concerns. If communities with EJ concerns have not been meaningfully engaged regarding concerns, additional outreach should be performed to ensure the impacted communities are meaningfully engaged throughout the NEPA process. Further, the final EIS and ROD should describe how the EIS weighed community preferences and concerns in deciding on the selected alternative and mitigation measures.

c) The draft EIS states that a literature and records review of the National Register of Historic Places, State records, and historic photographs was completed to identify cultural resources (page 69). However, the draft EIS does not mention whether community input was solicited to help identify culturally significant places not listed in historical records. In addition to requesting community feedback on culturally significant places and ground truthing the information gathered during research, community input would also be important to determine the best mitigation measures for the impacts to these resources. The final EIS should identify mitigation measures, including those for community cohesion, if culturally significant resources are identified in the project area.

VI. Air quality

The Clean Air Act requires the EPA to set National Ambient Air Quality Standards for six criteria air pollutants. Areas are designated as either in attainment, nonattainment, or unclassifiable for each standard and, as stated in section 4.2.1.8, Mississippi is currently in attainment for all NAAQS. Alternatives 2, 3, and 4 will result in either construction air emissions as well as emissions from the operation of the pumps once the project is complete or the operation of floodproofing equipment which is expected to emit air pollutants.

<u>Recommendations:</u>

a) Section 4.2.1.8 contains many vague and incorrect statements about air quality. The final EIS should quantify the potential air emissions and discuss the project's emissions in the context of the NAAQS, including construction and operation emissions of any criteria and hazardous air pollutants emitted by the project.

b) Section 4.2.1.8.1 should explain the purpose and use of social cost of carbon calculations and clarify the statements about the significance of individual greenhouse gases. For example, the second to last sentence in the section states that *"CO2 is the primary contributor to GHG and climate change, followed by CH4 and N20"* but does not include discussion of the global warming potential of different GHGs or fully explain that emissions of any GHG contribute to climate change. Moreover, sources of methane omit the potential sources in the project, and the abbreviation of nitrous oxide incorrectly uses a zero instead of a letter O.

c) On page 127, the draft EIS states that "*implementation of Alternative 2 would not interfere with the region's ability to maintain compliance with National Ambient Air Quality Standards for attainment area pollutants and would not interfere with the ability to achieve compliance for pollutants that contribute to ozone nonattainment.*" Section 5.1.8 should justify this statement along with the claims of insignificant air quality impacts with actual emissions data and modeling and comparison to air quality standards, if appropriate.

VII. Public Interest Review - Costs and Benefits

The draft EIS lacks information quantifying the anticipated costs and benefits of each alternative, as well as each of the monitoring and adaptive management components listed in Appendix K.

Recommendations:

a) To fully inform the USACE's public interest review, the final EIS should include information regarding the costs and benefits of each action alternative, including compensatory mitigation and each of the monitoring and adaptive management studies. Information about the potential costs of each alternative as well as the costs associated with current levels of flood damage in the YSA are important for the USACE in determining whether the project is in the public interest.

VIII. Transportation

Alternatives 2 and 3 involve management of backwater flooding to 90 feet during the crop season and 93 feet during the non-crop season. While structures below 90 and 93 feet would receive some level of flood protection, backwater flood events may still inundate certain transportation routes for long periods of time. Section 5.1 of the draft EIS discusses the structures and crop lands that would receive flood risk reduction benefits associated with each alternative, but the draft EIS does not discuss the potential for road closure isolating certain communities during backwater flood events in the YSA.

Recommendations:

a) The final EIS should include information that identifies the roads that would remain inundated by backwater flooding below 90 and 93 feet. A transportation analysis should be included in the final EIS that identifies structures that could be isolated by flooded roads during these events. The analysis may include a summary of the miles of roads, major highways impacted, and maps showing the YSA and impacted neighborhoods.
b) During previous backwater flood events, there were reports of increased use of the levee roads. These levees were not designed for high traffic volume, and overuse could present safety risks (e.g., collisions, levee road erosion, etc.). A collaboration with the Federal Emergency Management Agency and Mississippi Department of Transportation should be established to identify critical transportation routes that would benefit from floodproofing measures (e.g., elevating roads, reestablishing bridges). Such areas may include alternative routes to grocery stores, hospitals, schools, major highways, etc. that could simultaneously reduce drivers on the levee roads. The final EIS should include this analysis for public transparency and safety.

IX. Clean Water Act Section 404(b)(1) Evaluation

Projects that involve a discharge of dredged or fill material into waters of the U.S., such as this one, must comply with the Clean Water Act Section 404(b)(1) Guidelines (Guidelines). Many of the comments provided above are designed to ensure that the USACE has the information and analysis necessary to make the factual determinations described in Section 230.11 of the Guidelines. These factual determinations must be made to evaluate whether environmental impacts comply with the restrictions on discharge outlined in Section 230.10 and summarized again in Section 230.12 of the Guidelines.

The Guidelines (40 CFR 230.10(a)) only allow the discharge of dredged or fill material into waters of the United States for the Least Environmentally Damaging Practicable Alternative (LEDPA). An alternative is practicable if it is "*available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes*" (40 CFR 230.10(a)(2)). The draft EIS does not identify the LEDPA but instead indicates that all alternatives continue to be evaluated and that the LEDPA will be identified in the final EIS. As written, more information is necessary to determine which of Alternatives 2, 3, and 4 is the LEDPA.

According to Section 2036 of the Water Resources Development Act of 2007, "*the Secretary shall ensure that the mitigation plan for each water resources project complies with the mitigation standards and policies established pursuant to the regulatory programs administered by the Secretary.*" 33 U.S.C. § 2283(d)(3)(A). Compensatory mitigation is required for functional losses to waters of the U.S. and must follow the regulations outlined in 40 CFR §§ 230.91-98 and 33 CFR Part 332. These regulations are commonly referred to as the 2008 Mitigation Rule. The draft EIS does not yet contain a Rule-compliant mitigation strategy. While review of any compensatory mitigation plan is premature until it has been demonstrated that the LEDPA has been selected and the applicant has taken all practicable steps to avoid and minimize aquatic resource impacts (40 CFR § 230.91(c)), the following recommendations are provided to help address outstanding items required for development of a Rule-compliant mitigation plan, as well as general recommendations to more clearly document the rationale that justifies mitigation planning decisions.

Recommendations:

a) To inform and support LEPDA identification in the final EIS, the final EIS should include more complete information on the potential human and environmental impacts and benefits associated with each alternative.

b) Prior to the issuance of the Record of Decision for the project, compensatory mitigation plans consistent with 33 CFR 332.4(c) [40 CFR 230.94(c)] must be approved by the USACE. To facilitate public and interagency review of these plans, Appendix J of the final EIS should include as much detail as practicable regarding the elements of a mitigation plan required by 33 CFR 332.4(c) [40 CFR 230.94(c)].

c) Appendix J (Compensatory Mitigation Plan) should include a short summary of three MOAs described in Section 3 to clarify collaborative roles and to how the Compensatory Mitigation MOA would build upon the final EIS.

d) The final EIS should include a summary of potential impacts and required mitigation associated with each alternative, not just Alternative 2 (Appendix J, Table 3). These are needed to support the 404(b)(1) analysis, which then drives mitigation planning for unavoidable environmental impacts. As currently written, the document appears pre-decisional as it only discusses the maximum potential mitigation required but does not characterize it as such (e.g., Appendix J, pages 31, 39-40, and 44).

e) The final EIS should include a statement of the number of functional offsets that would be provided by each compensatory mitigation strategy.

f) Figure 2 (Appendix J) depicts land use in the YSA, not the extent of wetlands in the YSA. The final EIS should include a figure description that cites the data source used for this map. Additionally, page 15 states, *"For example, as discussed below, riverine backwater wetlands have been mapped across the LMRAV (Figure 2 below) and provide habitat for similar communities of fish and wildlife species."* This sentence should be deleted or clarified such that it does not refer to Figure 2 as showing mapped riverine backwater wetlands.

g) Section 6.1 (Appendix J) lists a number of GIS data layers that were used in planning. This section should include titles and dates of sources used, using citations to publicly available data where possible, and ensure that information referenced can be made available in the final EIS or on the project website if it is not publicly available elsewhere (e.g., inundation maps of the post-project floodplain).

h) Section 6.1 (Appendix J) introduces some site prioritization criteria but does not describe why they are important or how they will be used. Please provide an explanation to clearly document decision-making.

i) Figure 6 (Appendix J, page 32) introduces potential project-specific site locations near the 93- and 90-foot crop season boundaries. Please note that these elevations are the crop season boundaries for which the project is being managed, which are near the current estimated, pre-project, 2-year and 5-year floodplains. This Figure should be clarified to be consistent with the narrative throughout Appendix J, which states that compensatory mitigation sites would be located within the post-project, 2-year and 5-year floodplains.

j) Section 10.2 (Appendix J) further discusses project-specific mitigation. For any project-specific mitigation plans that would be implemented by the USACE, the site-specific mitigation plans should be provided in the final EIS that address the 12 components outlined in the Rule at 40 CFR Subpart J. One of these components requires a long-term management plan, which details site protection and management that is envisioned to be perpetual; for consistency with the Rule, please remove any language from the final EIS that suggests the USACE has no further responsibility for its compensatory mitigation sites after a 50-year project life (e.g., pages 41, 48, 52-54, and 62).

k) Section 13.3 (Appendix J, page 57) discusses certain scenarios where water levels could be managed to support wetland hydrology in times of drought. Because there are no proposed changes to this water level management feature, and because the topic of this appendix is related to compensatory mitigation, please remove this discussion from Appendix J.

l) The draft EIS also includes a discussion regarding the status of the USACE's efforts to address compensatory mitigation requirements associated with its completed MR&T projects in the YSA and Yazoo Backwater Area. The draft EIS notes that the total scope and status of the USACE's mitigation backlog to address impacts that were completed in the 1970s and 1980s will be provided in the final EIS. The final EIS must fully account for and provide firm commitments to expedite addressing its mitigation backlog in the YSA.

From: Louie Miller
To: GIPSON, JEREMIAH A COL USARMY CEMVK (USA); YazooBackwater MVK
Subject: [Non-DoD Source] RESUBMIT--MS Sierra Club Extension Request on Yazoo Backwater DEIS
Date: Wednesday, July 31, 2024 10:52:34 AM
Attachments: MS Sierra Club Corps letter extension request 6-11-24.pdf

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Hello--The MS Sierra Club is resubmitting our attached July 4 request for an extension of the Yazoo Backwater comment period on behalf of our 2,000+ members in MS; this is particularly urgent given the current Aug. 12 deadline.

Please acknowledge your receipt of this email.

Thank you,
Louie Miller

On Thu, Jul 4, 2024 at 5:11 PM Louie Miller <louie.miller@sierraclub.org> wrote:

> Good Afternoon:
>
> Please acknowledge receipt of the attached request. Thank you for your consideration.
>
> Sincerely,
>
> --
> Louie Miller
> State Director
> Sierra Club Mississippi
> 601-624-3503 (mobile)
> louie.miller@sierraclub.org

SIERRA CLUB
MISSISSIPPI CHAPTER

June 11, 2024

Submitted to christopher.d.klein@usace.army.mil and PearlRiverFRM@usace.army.mil

Colonel Christopher D. Klein
Commander, Vicksburg District
U.S. Army Corps of Engineers, CEMVK-PMP
4155 Clay Street
Vicksburg, MS 39183-343

Mr. Eric Williams
Chief, Environmental Branch
U.S. Army Corps of Engineers, CEMVN-PDS
7400 Leake Avenue
New Orleans, LA 70118

Re: MS Sierra Club Request for Extension of Public Comment Period on Pearl River Flood Risk Management Draft Environmental Impact Study

Dear Col. Klein and Mr. Williams:

On behalf of our 2,000+ members in Mississippi, many of whom would be directly impacted by this project, the Mississippi Sierra Club respectfully requests a 45-day extension of the public comment period for the U.S. Army Corps of Engineers (Corps) Pearl River Flood Risk Management Draft Environmental Impact Study (Draft Study). The requested extension is key to ensure that interested community members and stakeholders have a meaningful opportunity to review, evaluate, and prepare comments on the Draft Study.

As you are aware, the controversial Pearl River One Lake project threatens the health and safety of Jackson and downstream communities in Mississippi and Louisiana. These concerns include: increasing flood risks for Jackson communities, exposing community members to toxic pollution, altering downstream freshwater flows, reducing the Pearl River's water quality, jeopardizing seafood and tourism economies, worsening Jackson's drinking water crisis, causing massive environmental harm, and encouraging new development in areas at significant risk of flooding.

The Draft Study contains 3,950 pages, including 15 highly technical appendices. Interested stakeholders require additional time to review this information and develop educated comments.

For these reasons, we respectfully request a 45-day extension of the comment period, so that the public will have a total of 90 days to review the lengthy, very detailed Draft Study and provide comments.

Thank you for considering our request and we look forward to your prompt response.

Respectfully,

Louie Miller
State Director
Mississippi Chapter of the Sierra Club
Louie.Miller@sierraclub.org

From:	Louie Miller
To:	GIPSON, JEREMIAH A COL USARMY CEMVK (USA); YazooBackwater MVK
Subject:	[Non-DoD Source] Correction RESUBMIT--MS Sierra Club Extension Request on Yazoo Backwater DEIS
Date:	Wednesday, July 31, 2024 11:00:32 AM
Attachments:	MS Sierra Club Corps letter extension request 7-4-24.pdf

CORRECTION--Updated letter attached.

> Hello--The MS Sierra Club is resubmitting our attached July 4 request for an extension of the Yazoo Backwater comment period on behalf of our 2,000+ members in MS; this is particularly urgent given the current Aug. 12 deadline.
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>> Louie Miller
>> State Director
>> Sierra Club Mississippi
>> 601-624-3503 (mobile)
>> louie.miller@sierraclub.org

SIERRA CLUB
MISSISSIPPI CHAPTER

July 4, 2024

Delivered to Jeremiah.A.Gipson@usace.army.mil and YazooBackwater@usace.army.mil

Colonel Jeremiah A. Gipson
Vicksburg District Commander
U.S. Army Corps of Engineers
4155 Clay Street
Vicksburg, MS 39183-3435

Mr. Mike Renacker
Vicksburg District
U.S. Army Corps of Engineers
4155 Clay Street
Vicksburg, MS 39183-3435

Re: MS Sierra Club Request for Extension of Public Comment Period on Yazoo Backwater Area Water Management Project Draft Environmental Impact Statement

Dear Col. Gipson and Mr. Renacker:

On behalf of our 2,000+ members in Mississippi, the Mississippi Sierra Club respectfully requests a 45-day extension of the public comment period for the U.S. Army Corps of Engineers' (Corps) Yazoo Backwater Area Water Management Project Draft Environmental Impact Statement (EIS). The requested extension is crucial to ensure that our members, impacted communities, and other interested stakeholders have a meaningful opportunity to review and comment on the Draft EIS.

During the 2023 scoping phase of the Corps' Draft EIS for a preliminary Yazoo Pumps proposal, dozens of local community members and more than 130 conservation and social justice organizations submitted letters opposing the project's significant threat to hemispherically important wetlands and vulnerable communities. The Draft EIS recommends this highly controversial plan that would drain and damage hemispherically significant wetlands and pose increased flood risks for highly vulnerable downstream and backwater communities that suffer from pervasive and systemic environmental injustices.

Given these serious concerns, interested stakeholders require additional time to review and analyze the information in the 920+ pages included in the Draft EIS and multiple appendices. Notably, the Corps has only provided placeholders for numerous important appendices: Appendix B—Public Comments (scoping comments should be provided at this stage); Appendix C—State and Agency Comments (scoping comments should be provided at this stage); Appendix D-2—Fish and Wildlife Coordination Act Report; Appendix E—Programmatic Agreement; and Appendix G—Threatened and Endangered Species. Additionally, the Corps has not provided any assessment of project costs or benefits nor has it provided—or indicated that it has initiated—the required Independent External Peer Review.

For these reasons, we respectfully request a 45-day extension of the comment period, so that our members and the public will have a total of 90 days to review the Draft EIS and provide comments.

Thank you for considering our urgent request and we look forward to your prompt response.

Respectfully,

Louie Miller
State Director, Mississippi Chapter of the Sierra Club
Louie.Miller@sierraclub.org

From:	Mastrototaro, Jill
To:	YazooBackwater MVK; GIPSON, JEREMIAH A COL USARMY CEMVK (USA); Moore, Brian
Subject:	[Non-DoD Source] Resending--Audubon Comment Period Extension Request
Date:	Thursday, July 25, 2024 4:34:56 PM
Attachments:	Audubon Yazoo DEIS letter to Corps comment extn 7-3-24.pdf

Good Afternoon Colonel Gipson and Mr. Renacker,

With the conclusion of the Corps' public meetings earlier this week, Audubon would like to reiterate our request for an additional 45-day extension of the public comment period for the Yazoo Backwater Area Water Management Project Draft Environmental Impact Statement; reattached is our July 3, 2024, letter.

Thank you for your consideration.

Sincerely,
Jill

Jill Mastrototaro
Mississippi Policy Director, Audubon Delta

From: YazooBackwater MVK <YazooBackwater@usace.army.mil>
Sent: Monday, July 8, 2024 11:06 AM
To: Mastrototaro, Jill <Jill.Mastrototaro@audubon.org>; YazooBackwater MVK <YazooBackwater@usace.army.mil>; GIPSON, JEREMIAH A COL USARMY CEMVK (USA) <Jeremiah.A.Gipson@usace.army.mil>; Moore, Brian <Brian.Moore@audubon.org>
Subject: RE: Audubon Comment Period Extension Request

Thank you for your email. This is confirmation that your email has been received and being worked by the Yazoo Backwater Area Management team.

From: Mastrototaro, Jill <Jill.Mastrototaro@audubon.org>
Sent: Wednesday, July 3, 2024 11:56
To: YazooBackwater MVK <YazooBackwater@usace.army.mil>; GIPSON, JEREMIAH A COL USARMY CEMVK (USA) <Jeremiah.A.Gipson@usace.army.mil>; Moore, Brian <Brian.Moore@audubon.org>
Subject: [Non-DoD Source] Audubon Comment Period Extension Request

Good Afternoon:

Attached please find Audubon's letter urgently requesting an additional 45-day extension of the public comment period for the U.S. Army Corps of Engineers' Yazoo Backwater Area Water Management Project Draft Environmental Impact Statement.

Thank you for your consideration of our request, and thanks in advance for acknowledging receipt of our letter.

Sincerely,
Jill

Jill Mastrototaro
Mississippi Policy Director
504.481.3659

Audubon Delta
PO Box 2026
Ridgeland, MS 39158

Audubon

July 3, 2024

Sent by Electronic Mail to: YazooBackwater@usace.army.mil and Jeremiah.A.Gipson@usace.army.mil

Colonel Jeremiah A. Gipson
Vicksburg District Commander
U.S. Army Corps of Engineers
4155 Clay Street
Vicksburg, MS 39183-3435

Mr. Mike Renacker
Vicksburg District
U.S. Army Corps of Engineers
4155 Clay Street
Vicksburg, MS 39183-3435

Re: Audubon Request for Extension of Public Comment Period on Yazoo Backwater Area Water Management Project Draft Environmental Impact Statement

Dear Col. Gipson and Mr. Renacker:

On behalf of the National Audubon Society and our more than 1.6 million members, including nearly 38,000 members in our Audubon Delta region (AR, LA, MS), we respectfully request a 45-day extension of the public comment period for the U.S. Army Corps of Engineers' (Corps) Yazoo Backwater Area Water Management Project Draft Environmental Impact Statement (EIS). The requested extension is crucial to ensure that our members, impacted communities, and other interested stakeholders have a meaningful opportunity to review and comment on the Draft EIS.

As the Corps is aware, dozens of local community members and more than 130 conservation and social justice organizations submitted letters opposing the Corps' preliminary Yazoo Pumps proposal the during the 2023 scoping phase of the Draft EIS. This opposition was based on the project's significant threat to the area's hemispherically important wetlands and vulnerable communities. The Draft EIS recommends this highly controversial plan that would drain and damage hemispherically significant wetlands and pose increased flood risks for highly vulnerable downstream and backwater communities that suffer from pervasive and systemic environmental injustices.

Given these serious concerns, interested stakeholders require additional time to review and analyze the information in the more than 920 pages included in the Draft EIS and multiple technical appendices. We also note that the Corps has only provided placeholders for the following important appendices: Appendix B—Public Comments (scoping comments should be provided at this stage); Appendix C—State and Agency Comments (scoping comments should be provided at this stage); Appendix D-2—Fish and Wildlife Coordination Act Report; Appendix E—Programmatic Agreement; and Appendix G—Threatened and Endangered Species. Additionally, the Corps has not provided any assessment of project costs or benefits nor has it provided—or indicated that it has initiated—the required Independent External Peer Review.

Interested stakeholders like ours require additional time to review and analyze the information that has been posted, obtain and review the missing information, and prepare informed comments. For these reasons, **Audubon respectfully requests a 45-day extension of the comment period, so that our members and the public will have a total of 90 days to review the Draft EIS and provide comments.**

Thank you for considering our urgent request. We look forward to your prompt response.

Sincerely,

Brian Moore
Vice-President, Coast Policy, **National Audubon Society**
Interim Executive Director, **Audubon Delta**
Brian.Moore@audubon.org

Jill Mastrototaro
Mississippi Policy Director, **Audubon Delta**
Jill.Mastrototaro@audubon.org

From:	Louie Miller
To:	GIPSON, JEREMIAH A COL USARMY CEMVK (USA); YazooBackwater MVK
Subject:	[Non-DoD Source] MS Sierra Club Extension Request on Yazoo Backwater DEIS
Date:	Thursday, July 4, 2024 5:11:48 PM
Attachments:	MS Sierra Club Corps letter extension request 7-4-24.pdf

Good Afternoon:

Please acknowledge receipt of the attached request. Thank you for your consideration.

Sincerely,

--
Louie Miller
State Director
Sierra Club Mississippi
601-624-3503 (mobile)
louie.miller@sierraclub.org

July 4, 2024

Delivered to Jeremiah.A.Gipson@usace.army.mil and YazooBackwater@usace.army.mil

Colonel Jeremiah A. Gipson
Vicksburg District Commander
U.S. Army Corps of Engineers
4155 Clay Street
Vicksburg, MS 39183-3435

Mr. Mike Renacker
Vicksburg District
U.S. Army Corps of Engineers
4155 Clay Street
Vicksburg, MS 39183-3435

Re: MS Sierra Club Request for Extension of Public Comment Period on Yazoo Backwater Area Water Management Project Draft Environmental Impact Statement

Dear Col. Gipson and Mr. Renacker:

On behalf of our 2,000+ members in Mississippi, the Mississippi Sierra Club respectfully requests a 45-day extension of the public comment period for the U.S. Army Corps of Engineers' (Corps) Yazoo Backwater Area Water Management Project Draft Environmental Impact Statement (EIS). The requested extension is crucial to ensure that our members, impacted communities, and other interested stakeholders have a meaningful opportunity to review and comment on the Draft EIS.

During the 2023 scoping phase of the Corps' Draft EIS for a preliminary Yazoo Pumps proposal, dozens of local community members and more than 130 conservation and social justice organizations submitted letters opposing the project's significant threat to hemispherically important wetlands and vulnerable communities. The Draft EIS recommends this highly controversial plan that would drain and damage hemispherically significant wetlands and pose increased flood risks for highly vulnerable downstream and backwater communities that suffer from pervasive and systemic environmental injustices.

Given these serious concerns, interested stakeholders require additional time to review and analyze the information in the 920+ pages included in the Draft EIS and multiple appendices. Notably, the Corps has only provided placeholders for numerous important appendices: Appendix B—Public Comments (scoping comments should be provided at this stage); Appendix C—State and Agency Comments (scoping comments should be provided at this stage); Appendix D-2—Fish and Wildlife Coordination Act Report; Appendix E—Programmatic Agreement; and Appendix G—Threatened and Endangered Species. Additionally, the Corps has not provided any assessment of project costs or benefits nor has it provided—or indicated that it has initiated—the required Independent External Peer Review.

For these reasons, we respectfully request a 45-day extension of the comment period, so that our members and the public will have a total of 90 days to review the Draft EIS and provide comments.

Thank you for considering our urgent request and we look forward to your prompt response.

Respectfully,

Louie Miller
State Director, Mississippi Chapter of the Sierra Club
Louie.Miller@sierraclub.org

From:	Kelsey Cruickshank
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Yazoo Backwater Extension Request
Date:	Monday, July 15, 2024 9:38:39 AM
Attachments:	Yazoo Extension Request.pdf

Hello,

Please see American Rivers' request for an extension of the public comment period for the Yazoo Backwater attached.

Thank you,
Kelsey

Kelsey Cruickshank
Director, Policy and Government Relations
202-243-7067
AmericanRivers.org
America's Most Endangered Rivers® of 2024 is a call to action for clean water. Learn about 10 rivers at risk — and how you can help. AmericanRivers.org/EndangeredRivers

Via email: YazooBackwater@usace.army.mil

Colonel Jeremiah A. Gipson
Vicksburg District Commander
U.S. Army Corps of Engineers
4155 Clay Street
Vicksburg, MS 39183-3435

Mr. Mike Renacker
Vicksburg District
U.S. Army Corps of Engineers
4155 Clay Street
Vicksburg, MS 39183-3435

Re: Request for Extension of Public Comment Period on Yazoo Backwater Area Water Management Project Draft Environmental Impact Statement

Dear Col. Gipson and Mr. Renacker:

American Rivers requests a 45-day extension of the public comment period for the U.S. Army Corps of Engineers (Corps) Yazoo Backwater Area Water Management Project Draft Environmental Impact Statement (Draft EIS). This extension is crucial to provide all stakeholders, including community members and conservation organizations with relevant expertise, with sufficient time to meaningfully review the Draft EIS for the Yazoo Backwater.

As the Corps is aware, the Draft EIS recommends a highly controversial plan, opposed by over 130 conservation groups and dozens of community stakeholders. At full capacity, the proposed pumps would push 16 billion gallons of water a day into an already flooded Yazoo River, increasing flood risks for highly vulnerable downstream communities that already suffer from pervasive and systemic environmental injustices.

Given the significant risks of a project of this magnitude, interested stakeholders require additional time to review and analyze the Draft EIS, which is more than 920 pages. Further, the Corps has only provided placeholders for the following appendices: App. B—Public Comments (should include scoping comments); App. C—State and Agency Comments (should scoping comments); App. D-2—Fish and Wildlife Coordination Act Report; App. E—Programmatic Agreement; and App. G—Threatened and Endangered Species. The Corps has also failed to provide any assessment of project costs or benefits and has not provided (or indicated that it has initiated) the required Independent External Peer Review.

Stakeholders, including American Rivers, require additional time to review and analyze the information that has been posted, obtain and review the missing information, and prepare informed comments. For these reasons, American Rivers requests a 45-day extension of the comment period, so that the public will have a total of 90 days to review the Draft EIS and provide comments.

Thank you for considering this request. I look forward to your prompt response.

Sincerely,

Kelsey Cruickshank
Government Relations Director
American Rivers

From:	Mastrototaro, Jill
To:	YazooBackwater MVK; GIPSON, JEREMIAH A COL USARMY CEMVK (USA); Moore, Brian
Subject:	[Non-DoD Source] Audubon Comment Period Extension Request
Date:	Wednesday, July 3, 2024 11:57:39 AM
Attachments:	Audubon Yazoo DEIS letter to Corps comment extn 7-3-24.pdf

Good Afternoon:

Attached please find Audubon's letter urgently requesting an additional 45-day extension of the public comment period for the U.S. Army Corps of Engineers' Yazoo Backwater Area Water Management Project Draft Environmental Impact Statement.

Thank you for your consideration of our request, and thanks in advance for acknowledging receipt of our letter.

Sincerely,
Jill

Jill Mastrototaro
Mississippi Policy Director
504.481.3659

Audubon Delta
PO Box 2026
Ridgeland, MS 39158

Audubon

July 3, 2024

Sent by Electronic Mail to: YazooBackwater@usace.army.mil and Jeremiah.A.Gipson@usace.army.mil

Colonel Jeremiah A. Gipson
Vicksburg District Commander
U.S. Army Corps of Engineers
4155 Clay Street
Vicksburg, MS 39183-3435

Mr. Mike Renacker
Vicksburg District
U.S. Army Corps of Engineers
4155 Clay Street
Vicksburg, MS 39183-3435

Re: Audubon Request for Extension of Public Comment Period on Yazoo Backwater Area Water Management Project Draft Environmental Impact Statement

Dear Col. Gipson and Mr. Renacker:

On behalf of the National Audubon Society and our more than 1.6 million members, including nearly 38,000 members in our Audubon Delta region (AR, LA, MS), we respectfully request a 45-day extension of the public comment period for the U.S. Army Corps of Engineers' (Corps) Yazoo Backwater Area Water Management Project Draft Environmental Impact Statement (EIS). The requested extension is crucial to ensure that our members, impacted communities, and other interested stakeholders have a meaningful opportunity to review and comment on the Draft EIS.

As the Corps is aware, dozens of local community members and more than 130 conservation and social justice organizations submitted letters opposing the Corps' preliminary Yazoo Pumps proposal the during the 2023 scoping phase of the Draft EIS. This opposition was based on the project's significant threat to the area's hemispherically important wetlands and vulnerable communities. The Draft EIS recommends this highly controversial plan that would drain and damage hemispherically significant wetlands and pose increased flood risks for highly vulnerable downstream and backwater communities that suffer from pervasive and systemic environmental injustices.

Given these serious concerns, interested stakeholders require additional time to review and analyze the information in the more than 920 pages included in the Draft EIS and multiple technical appendices. We also note that the Corps has only provided placeholders for the following important appendices: Appendix B—Public Comments (scoping comments should be provided at this stage); Appendix C—State and Agency Comments (scoping comments should be provided at this stage); Appendix D-2—Fish and Wildlife Coordination Act Report; Appendix E—Programmatic Agreement; and Appendix G—Threatened and Endangered Species. Additionally, the Corps has not provided any assessment of project costs or benefits nor has it provided—or indicated that it has initiated—the required Independent External Peer Review.

Interested stakeholders like ours require additional time to review and analyze the information that has been posted, obtain and review the missing information, and prepare informed comments. For these reasons, **Audubon respectfully requests a 45-day extension of the comment period, so that our members and the public will have a total of 90 days to review the Draft EIS and provide comments.**

Thank you for considering our urgent request. We look forward to your prompt response.

Sincerely,

Brian Moore
Vice-President, Coast Policy, **National Audubon Society**
Interim Executive Director, **Audubon Delta**
Brian.Moore@audubon.org

Jill Mastrototaro
Mississippi Policy Director, **Audubon Delta**
Jill.Mastrototaro@audubon.org

From:	Stu Gillespie
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] RE: Request for Extension of Public Comment Period on Yazoo Backwater Area Water Management Project Draft Environmental Impact Statement
Date:	Thursday, August 1, 2024 1:31:13 PM

Good afternoon –

Earthjustice once again reiterates our request for a 45-day extension of time to comment on the Yazoo Backwater Pumping plant project. We submitted our request over a month ago. We would appreciate a response by tomorrow if possible since the current comment period closes on August 12th.

Thank you again for considering this request and for the courtesy of a prompt response.

Stu

From: YazooBackwater MVK <YazooBackwater@usace.army.mil>
Sent: Tuesday, July 16, 2024 2:48 PM
To: Stu Gillespie <sgillespie@earthjustice.org>
Subject: RE: Request for Extension of Public Comment Period on Yazoo Backwater Area Water Management Project Draft Environmental Impact Statement

External Sender

The U.S. Army Corps of Engineers, Vicksburg District is currently evaluating your request with consultation from EPA and ASA(CW). A final decision has not been made yet but will be forthcoming eminently. Once I am notified of the final disposition of your request, I will convey that decision to you directly.

From: Stu Gillespie <sgillespie@earthjustice.org>
Sent: Friday, June 28, 2024 18:18
To: YazooBackwater MVK <YazooBackwater@usace.army.mil>
Subject: [Non-DoD Source] Request for Extension of Public Comment Period on Yazoo Backwater Area Water Management Project Draft Environmental Impact Statement

Dear Col. Gipson and Mr. Renacker,

Please find attached Earthjustice's request for an extension of the public comment period on the Yazoo Backwater Area Water Management Project Draft Environmental Impact Statement. Thank you for considering this request.

Sincerely,
Stu

From:	Stu Gillespie
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Request for Extension of Public Comment Period on Yazoo Backwater Area Water Management Project Draft Environmental Impact Statement
Date:	Friday, June 28, 2024 6:21:04 PM
Attachments:	2024-06-28 Yazoo Pumps DEIS Extension Request.pdf

Dear Col. Gipson and Mr. Renacker,

Please find attached Earthjustice's request for an extension of the public comment period on the Yazoo Backwater Area Water Management Project Draft Environmental Impact Statement. Thank you for considering this request.

Sincerely,
Stu

June 28, 2024

Via email: YazooBackwater@usace.army.mil

Colonel Jeremiah A. Gipson	Mr. Mike Renacker
Vicksburg District Commander	Vicksburg District
U.S. Army Corps of Engineers	U.S. Army Corps of Engineers
4155 Clay Street	4155 Clay Street
Vicksburg, MS 39183-3435	Vicksburg, MS 39183-3435

Re: Request for Extension of Public Comment Period on Yazoo Backwater Area Water Management Project Draft Environmental Impact Statement

Dear Col. Gipson and Mr. Renacker:

Earthjustice respectfully requests a 45-day extension of the public comment period for the U.S. Army Corps of Engineers (Corps) Yazoo Backwater Area Water Management Project Draft Environmental Impact Statement (Draft EIS). The requested extension is critical for providing stakeholders and interested community members with a meaningful opportunity to review and comment on the Draft EIS.

As the Corps is aware, dozens of local community members and more than 130 conservation and social justice organizations submitted letters opposing the Corps' preliminary proposal for the Yazoo Pumps during the during the scoping phase of the Draft EIS. This opposition was based on the project's significant threat to the region's hemispherically significant wetlands and vulnerable communities. The Draft EIS recommends this highly controversial plan, proposing a pumping plant with the capacity to drain enough water from the Yazoo Backwater Area each day to fill more than 17 New Orleans' Superdomes, draining and damaging hemispherically significant wetlands. At full capacity, these pumps would push 16 billion gallons of water a day into an already flooded Yazoo River, increasing flood risks for highly vulnerable downstream communities that suffer from pervasive and systemic environmental injustices.

Given these highly significant risks, interested stakeholders require additional time to review and analyze the information in the more than 920 pages included in the Draft EIS and multiple technical appendices. We also note that the Corps has only provided placeholders for the following important appendices: App. B—Public Comments (which at this stage should provide scoping comments); App. C—State and Agency Comments (which at this stage should provide scoping comments); App. D-2—Fish and Wildlife Coordination Act Report; App. E—Programmatic Agreement; and App. G—Threatened and Endangered Species. The Corps also has not provided any assessment of project costs or benefits and has not provided (or indicated that it has initiated) the required Independent External Peer Review.

ROCKY MOUNTAIN OFFICE 633 16th Street, Suite 1600 DENVER, CO

T: 303-996-9616 INFO@EARTHJUSTICE.ORG WWW.EARTHJUSTICE.ORG

Interested stakeholders require additional time to review and analyze the information that has been posted, obtain, and review the missing information, and prepare informed comments. For these reasons, Earthjustice requests a 45-day extension of the comment period, so that the public will have a total of 90 days to review the Draft EIS and provide comments.

Thank you for considering this reasonable request, and I look forward to your prompt response.

Sincerely,

/s/ Stu Gillespie
Stu Gillespie
Earthjustice
633 16th Street, Suite 1600
Denver, CO 80202
(303) 623-9466
sgillespie@earthjustice.org

From:	Melissa Samet
To:	GIPSON, JEREMIAH A COL USARMY CEMVK (USA); YazooBackwater MVK
Subject:	[Non-DoD Source] Following Up: National Wildlife Federation Extension Request on Yazoo Backwater DEIS
Date:	Tuesday, July 16, 2024 2:58:30 PM
Attachments:	NWF Ltr Requesting Extension of Comment Period Yazoo Pumps DSEIS Final 7-8-24.pdf

Good afternoon, I am following up on the attached request for an extension of time to submit comments on the Yazoo Backwater Area Water Management project draft EIS. I know that multiple other groups also submitted similar requests. We would appreciate receiving an answer to this request as soon as possible.

Thank you.

Melissa Samet
Legal Director, Water Resources and Coasts
National Wildlife Federation
(o) 415-762-8264
(c) 415-577-9193
sametm@nwf.org

From: Melissa Samet
Sent: Monday, July 8, 2024 8:52 AM
To: Jeremiah.A.Gipson@usace.army.mil; Yazoobackwater@usace.army.mil
Subject: National Wildlife Federation Extension Request on Yazoo Backwater DEIS

Good morning,

Please see the attached letter requesting a 45-day extension of time to comment on the Yazoo Backwater Pumping plant project.

Thank you for your prompt consideration of this request.

I would also appreciate it if you would reply to this email to acknowledge receipt.

Melissa Samet
Legal Director, Water Resources and Coasts
National Wildlife Federation
(o) 415-762-8264
(c) 415-577-9193
sametm@nwf.org

From: Melissa Samet
To: GIPSON, JEREMIAH A COL USARMY CEMVK (USA); YazooBackwater MVK
Subject: [Non-DoD Source] National Wildlife Federation Extension Request on Yazoo Backwater DEIS
Date: Monday, July 8, 2024 10:54:40 AM
Attachments: NWF Ltr Requesting Extension of Comment Period Yazoo Pumps DSEIS Final 7-8-24.pdf

---

Good morning,

Please see the attached letter requesting a 45-day extension of time to comment on the Yazoo Backwater Pumping plant project.

Thank you for your prompt consideration of this request.

I would also appreciate it if you would reply to this email to acknowledge receipt.

Melissa Samet
Legal Director, Water Resources and Coasts
National Wildlife Federation
(o) 415-762-8264
(c) 415-577-9193
sametm@nwf.org

From: Melissa Samet
To: YazooBackwater MVK; GIPSON, JEREMIAH A COL USARMY CEMVK (USA)
Subject: [Non-DoD Source] RE: National Wildlife Federation Extension Request on Yazoo Backwater DEIS
Date: Tuesday, July 23, 2024 1:00:16 PM
Importance: High

The National Wildlife Federation once again reiterates our request for a 45-day extension of time to comment on the Yazoo Backwater Pumping plant project. We would appreciate a response by tomorrow if possible since the current comment period closes in less than 3 weeks.

Thank you again for considering this request and for the courtesy of a prompt response.

Melissa Samet
Legal Director, Water Resources and Coasts
National Wildlife Federation
(o) 415-762-8264
(c) 415-577-9193
sametm@nwf.org

From: YazooBackwater MVK <YazooBackwater@usace.army.mil>
Sent: Tuesday, July 16, 2024 1:48 PM
To: Melissa Samet <sametm@nwf.org>; GIPSON, JEREMIAH A COL USARMY CEMVK (USA) <Jeremiah.A.Gipson@usace.army.mil>
Subject: [EXTERNAL] RE: National Wildlife Federation Extension Request on Yazoo Backwater DEIS

The U.S. Army Corps of Engineers, Vicksburg District is currently evaluating your request with consultation from EPA and ASA(CW). A final decision has not been made yet but will be forthcoming eminently. Once I am notified of the final disposition of your request, I will convey that decision to you directly.

From: Melissa Samet <sametm@nwf.org>
Sent: Monday, July 8, 2024 10:52
To: GIPSON, JEREMIAH A COL USARMY CEMVK (USA) <Jeremiah.A.Gipson@usace.army.mil>; YazooBackwater MVK <YazooBackwater@usace.army.mil>
Subject: [Non-DoD Source] National Wildlife Federation Extension Request on Yazoo Backwater DEIS

Good morning,

Please see the attached letter requesting a 45-day extension of time to comment on the Yazoo Backwater Pumping plant project.

Thank you for your prompt consideration of this request.

I would also appreciate it if you would reply to this email to acknowledge receipt.

Melissa Samet
Legal Director, Water Resources and Coasts
National Wildlife Federation
(o) 415-762-8264
(c) 415-577-9193
sametm@nwf.org

National Wildlife Federation
National Advocacy Center
1200 G Street NW, Suite 900 • Washington, DC 20005 • 202-797-6800

July 8, 2024

Via email: Jeremiah.A.Gipson@usace.army.mil; YazooBackwater@usace.army.mil

Colonel Jeremiah A. Gipson
Vicksburg District Commander
U.S. Army Corps of Engineers
4155 Clay Street
Vicksburg, MS 39183-3435

Mr. Mike Renacker
Vicksburg District
U.S. Army Corps of Engineers
4155 Clay Street
Vicksburg, MS 39183-3435

Re: Request for Extension of Public Comment Period on Yazoo Backwater Area Water Management Project Draft Environmental Impact Statement

Dear Col. Gipson and Mr. Renacker:

On behalf of our millions of members and supporters, the National Wildlife Federation requests a 45-day extension of the public comment period for the U.S. Army Corps of Engineers (Corps) Yazoo Backwater Area Water Management Project Draft Environmental Impact Statement (Draft EIS). The requested extension is critical for providing stakeholders and interested community members with a meaningful opportunity to review and comment on the Draft EIS.

As the Corps is aware, dozens of local community members and more than 130 conservation and social justice organizations submitted letters opposing the Corps' preliminary proposal for the Yazoo Pumps during the during the scoping phase of the Draft EIS. This opposition was based on the project's significant threat to the region's hemispherically significant wetlands and vulnerable communities. The Draft EIS recommends this highly controversial plan, proposing a pumping plant with the capacity to drain enough water from the Yazoo Backwater Area each day to fill more than 17 New Orleans' Superdomes, draining and damaging hemispherically significant wetlands. At full capacity, these pumps would push 16 billion gallons of water a day into an already flooded Yazoo River, increasing flood risks for highly vulnerable downstream communities that suffer from pervasive and systemic environmental injustices.

Given these highly significant risks, interested stakeholders require additional time to review and analyze the information in the more than 920 pages included in the Draft EIS and multiple technical appendices. We also note that the Corps has only provided placeholders for the following important appendices: App. B—Public Comments (which at this stage should provide scoping comments); App. C—State and Agency Comments (which at this stage should provide scoping comments); App. D-2—Fish and Wildlife Coordination Act Report; App. E—Programmatic Agreement; and App. G—Threatened and Endangered Species. The Corps also has not provided any assessment of project costs or benefits and has not provided (or indicated that it has initiated) the required Independent External Peer Review.

Interested stakeholders require additional time to review and analyze the information that has been posted, obtain, and review the missing information, and prepare informed comments. For these reasons, the National Wildlife Federation requests a 45-day extension of the comment period, so that the public will have a total of 90 days to review the Draft EIS and provide comments.

Thank you for considering this request and I look forward to your prompt response.

Sincerely,

Melissa Samet
Legal Director, Water Resources and Coasts
sametm@nwf.org

From:	Andrew Whitehurst
To:	YazooBackwater MVK
Subject:	[Non-DoD Source] Letter from Healthy Gulf requesting extension to comment period
Date:	Tuesday, July 2, 2024 1:25:02 AM
Attachments:	Healthy Gulf Extenstion of Time Request Letter Yazoo July 1, 2024.docx

Via email: YazooBackwater@usace.army.mil

July 1, 2024

Colonel Jeremiah A. Gipson
Vicksburg District Commander
U.S. Army Corps of Engineers
4155 Clay Street
Vicksburg, MS 39183-3435

Mr. Mike Renacker
Vicksburg District
U.S. Army Corps of Engineers
4155 Clay Street
Vicksburg, MS 39183-3435
Re: Request for Extension of Public Comment Period on Yazoo Backwater Area Water Management Project Draft Environmental Impact Statement

Dear Col. Gipson and Mr. Renacker:

Healthy Gulf was involved in examining DEIS documents and commenting on the Yazoo Pump project in 2007 and in subsequent versions of the project. It requests a 45-day extension of the public comment period for the U.S. Army Corps of Engineers (Corps) Yazoo Backwater Area Water Management Project Draft Environmental Impact Statement (Draft EIS). The requested extension is critical for providing stakeholders and interested community members with a meaningful opportunity to review and comment on the Draft EIS.

As the Corps is aware, dozens of local community members and more than 130 conservation and social justice organizations submitted letters opposing the Corps' preliminary proposal for the Yazoo Pumps during the during the scoping phase of the Draft EIS. This opposition was based on the project's significant threat to the region's hemispherically significant wetlands and vulnerable communities. The Draft EIS recommends this highly controversial plan, proposing a pumping plant with the capacity to drain enough water from the Yazoo Backwater Area each day to fill more than 17 New Orleans' Superdomes, draining and damaging hemispherically significant wetlands, and increasing flood risks for highly vulnerable downstream communities that suffer from pervasive and systemic environmental injustices.

Stakeholders require additional time to review and analyze the information in the more than 920 pages included in the Draft EIS and multiple technical appendices. We also note that the Corps has only provided placeholders for the following important appendices: App. B—Public Comments (which at this stage should provide scoping comments); App. C—State and Agency Comments (which at this stage should provide scoping comments); App. D-2—Fish and Wildlife Coordination Act Report; App. E—Programmatic Agreement; and App. G—Threatened and Endangered Species. The Corps also has not provided any assessment of project costs or benefits and has not provided the required Independent External Peer Review.

Interested stakeholders require additional time to review and analyze the information that has been posted, obtain, and review the missing information, and prepare informed comments.
For these reasons, Healthy Gulf requests a 45-day extension of the comment period, so that the public will have a total of 90 days to review the Draft EIS and provide comments.

Thank you for considering this request and I look forward to your prompt response.

Andrew Whitehurst, Water Program Director, Healthy Gulf, andrew@healthygulf.org

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Healthy Gulf Home

Andrew Whitehurst

He/Him
Water Program Director

601 954 7236 (cell)

PO Box 2245
New Orleans, LA 70176

Protect What You Love

Via email: YazooBackwater@usace.army.mil

Colonel Jeremiah A. Gipson
Vicksburg District Commander
U.S. Army Corps of Engineers
4155 Clay Street
Vicksburg, MS 39183-3435

Mr. Mike Renacker
Vicksburg District
U.S. Army Corps of Engineers
4155 Clay Street
Vicksburg, MS 39183-3435

Re: Request for Extension of Public Comment Period on Yazoo Backwater Area Water Management Project Draft Environmental Impact Statement

Dear Col. Gipson and Mr. Renacker:

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Stakeholders require additional time to review and analyze the information in the more than 920 pages included in the Draft EIS and multiple technical appendices. We also note that the Corps has only provided placeholders for the following important appendices: App. B—Public Comments (which at this stage should provide scoping comments); App. C—State and Agency Comments (which at this stage should provide scoping comments); App. D-2—Fish and Wildlife Coordination Act Report; App. E—Programmatic Agreement; and App. G—Threatened and Endangered Species. The Corps also has not provided any assessment of project costs or benefits and has not provided the required Independent External Peer Review. Interested stakeholders require additional time to review and analyze the information that has been posted, obtain, and review the missing information, and prepare informed comments. For these reasons, Healthy Gulf requests a 45-day extension of the comment period, so that the public will have a total of 90 days to review the Draft EIS and provide comments.

Thank you for considering this request and I look forward to your prompt response.

Andrew Whitehurst

Andrew Whitehurst, Water Program Director, Healthy Gulf, andrew@healthygulf.org (601) 954-7236

From:	Melissa Samet
To:	YazooBackwater MVK; GIPSON, JEREMIAH A COL USARMY CEMVK (USA)
Subject:	[Non-DoD Source] RE: National Wildlife Federation Extension Request on Yazoo Backwater DEIS
Date:	Tuesday, July 23, 2024 1:00:16 PM
Importance:	High

The National Wildlife Federation once again reiterates our request for a 45-day extension of time to comment on the Yazoo Backwater Pumping plant project. We would appreciate a response by tomorrow if possible since the current comment period closes in less than 3 weeks.

Thank you again for considering this request and for the courtesy of a prompt response.

Melissa Samet
Legal Director, Water Resources and Coasts
National Wildlife Federation
(o) 415-762-8264
(c) 415-577-9193
sametm@nwf.org

From: YazooBackwater MVK <YazooBackwater@usace.army.mil>
Sent: Tuesday, July 16, 2024 1:48 PM
To: Melissa Samet <sametm@nwf.org>; GIPSON, JEREMIAH A COL USARMY CEMVK (USA) <Jeremiah.A.Gipson@usace.army.mil>
Subject: [EXTERNAL] RE: National Wildlife Federation Extension Request on Yazoo Backwater DEIS

The U.S. Army Corps of Engineers, Vicksburg District is currently evaluating your request with consultation from EPA and ASA(CW). A final decision has not been made yet but will be forthcoming eminently. Once I am notified of the final disposition of your request, I will convey that decision to you directly.

From: Melissa Samet <sametm@nwf.org>
Sent: Monday, July 8, 2024 10:52
To: GIPSON, JEREMIAH A COL USARMY CEMVK (USA) <Jeremiah.A.Gipson@usace.army.mil>; YazooBackwater MVK <YazooBackwater@usace.army.mil>
Subject: [Non-DoD Source] National Wildlife Federation Extension Request on Yazoo Backwater DEIS

Good morning,

Please see the attached letter requesting a 45-day extension of time to comment on the Yazoo Backwater Pumping plant project.

Thank you for your prompt consideration of this request.

I would also appreciate it if you would reply to this email to acknowledge receipt.

Melissa Samet
Legal Director, Water Resources and Coasts
National Wildlife Federation
(o) 415-762-8264
(c) 415-577-9193
sametm@nwf.org

National Wildlife Federation
National Advocacy Center
1200 G Street NW, Suite 900 • Washington, DC 20005 • 202-797-6800

July 8, 2024

Via email: Jeremiah.A.Gipson@usace.army.mil; YazooBackwater@usace.army.mil

Colonel Jeremiah A. Gipson
Vicksburg District Commander
U.S. Army Corps of Engineers
4155 Clay Street
Vicksburg, MS 39183-3435

Mr. Mike Renacker
Vicksburg District
U.S. Army Corps of Engineers
4155 Clay Street
Vicksburg, MS 39183-3435

Re: Request for Extension of Public Comment Period on Yazoo Backwater Area Water Management Project Draft Environmental Impact Statement

Dear Col. Gipson and Mr. Renacker:

On behalf of our millions of members and supporters, the National Wildlife Federation requests a 45-day extension of the public comment period for the U.S. Army Corps of Engineers (Corps) Yazoo Backwater Area Water Management Project Draft Environmental Impact Statement (Draft EIS). The requested extension is critical for providing stakeholders and interested community members with a meaningful opportunity to review and comment on the Draft EIS.

As the Corps is aware, dozens of local community members and more than 130 conservation and social justice organizations submitted letters opposing the Corps' preliminary proposal for the Yazoo Pumps during the during the scoping phase of the Draft EIS. This opposition was based on the project's significant threat to the region's hemispherically significant wetlands and vulnerable communities. The Draft EIS recommends this highly controversial plan, proposing a pumping plant with the capacity to drain enough water from the Yazoo Backwater Area each day to fill more than 17 New Orleans' Superdomes, draining and damaging hemispherically significant wetlands. At full capacity, these pumps would push 16 billion gallons of water a day into an already flooded Yazoo River, increasing flood risks for highly vulnerable downstream communities that suffer from pervasive and systemic environmental injustices.

Given these highly significant risks, interested stakeholders require additional time to review and analyze the information in the more than 920 pages included in the Draft EIS and multiple technical appendices. We also note that the Corps has only provided placeholders for the following important appendices: App. B—Public Comments (which at this stage should provide scoping comments); App. C—State and Agency Comments (which at this stage should provide scoping comments); App. D-2—Fish and Wildlife Coordination Act Report; App. E—Programmatic Agreement; and App. G—Threatened and Endangered Species. The Corps also has not provided any assessment of project costs or benefits and has not provided (or indicated that it has initiated) the required Independent External Peer Review.

Interested stakeholders require additional time to review and analyze the information that has been posted, obtain, and review the missing information, and prepare informed comments. For these reasons, the National Wildlife Federation requests a 45-day extension of the comment period, so that the public will have a total of 90 days to review the Draft EIS and provide comments.

Thank you for considering this request and I look forward to your prompt response.

Sincerely,

Melissa Samet
Legal Director, Water Resources and Coasts
sametm@nwf.org

Comment Number	Comment Date	Org.	Theme	Comment	Response
1	6/28/2024	General Public	General Support	We are the only area that flood control was not used from years ago, since we were left out, catastrophic flooding has occurred. Not only towns and communities were damaged, but the wildlife was destroyed by drowning, lack of food, they were horribly starved. The natural flora and fauna was also destroyed, where some will probably never come back, farmland was damaged, trees were actually drowned, where their root system can't get air to survive and died! Please put them in . Every living thing has been severely affected and compromised by the tragic floods due to lack of the flood control by the Army Corp of Engineers.	The U.S. Corps of Engineers (USACE), Vicksburg District, thanks you for your support of the project. The mission of USACE under federal law is to deliver to the American people the flood risk management benefits approved by Congress. This project involves competing interests (agricultural interests versus ecological value). Alternatives were formulated with the goal of managing flood risks to agricultural lands while at the same time recognizing the importance of flooding to the remaining natural environment. Proposed mitigation compensates for impacts to waters of the United States pursuant to Section 404 of the Clean Water Act and significant impacts to fish and wildlife resources pursuant to USACE Civil Works policy. USACE has documented that proposed compensatory mitigation is commensurate with unavoidable impacts and that adequate safeguards are in place to ensure mitigation success and occurs concurrent with project impacts.
2	6/28/2024	General Public	General Support	I would like to be on record as fully supporting the Yazoo Backwater pumps.	See response to comment 1
3	6/28/2024	General Public	General Support	The picture shown on this website is showing my family land. There was a time when my grandfather made a living off this land and very rarely it flooded. Because of the pumps it floods regularly now and we are lucky to make $3k off the land now farming it. It is detrimental to the family! Pumps! Pumps! Pumps!	See response to comment 1
4	6/28/2024	NGO- Earth Justice	NEPA	Earthjustice rquests a 45-day extension of the public comment period for the U.S. Army Corps of Engineers (Corps) Yazoo Backwater Area Water Management Project Draft Environmental Impact Statement (Draft EIS). The requested extension is critical for providing stakeholders and interested community members with a meaningful opportunity to review and comment on the Draft EIS.	Comment noted. The public comment period was extended to 60 total days and closed on 27AUG24,
5	6/29/2024	NGO- Earth Justice	General Opposition	The Draft EIS recommends this highly controversial plan, proposing a pumping plant with the capacity to drain enough water from the Yazoo Backwater Area each day to fill more than 17 New Orleans' Superdomes, draining and damaging hemispherically significant wetlands.	The U.S. Corps of Engineers (USACE), Vicksburg District, thanks you for your interest in the project. The mission of USACE under federal law is to deliver to the American people the flood risk management benefits approved by Congress. This project involves competing interests (agricultural interests versus ecological value). Alternatives were formulated with the goal of managing flood risks to agricultural lands while at the same time recognizing the importance of flooding to the remaining natural environment. USACE has undertaken a suite of environmental models to quantify the value of flooding to resources in the project area. Environmental models used in impacts analysis were developed by subject matter experts who also conducted the project-specific analysis that was used to determine impacts and quantify mitigation. Avoid and minimize measures were formulated to reduce the direct impact as well as to maintain levels of hydrologic connectivity to the Yazoo and Mississippi Rivers. The lost flood storage of the backwater area would have no effect on downstream communities and the corresponding protective Mississippi River Levee system. As seen in the proposed mitigation measures, a watershed approach to compensatory mitigation has been proposed. USACE has developed, through collaboration with the interagency team, mitigation measures that incorporate a full range of resource management activities. Proposed mitigation compensates for impacts to waters of the United States pursuant to Section 404 of the Clean Water Act and significant impacts to fish and wildlife resources pursuant to USACE Civil Works policy. USACE has documented that proposed compensatory mitigation is commensurate with unavoidable impacts and that adequate safeguards are in place to ensure mitigation success and occurs concurrent with project impacts.
6	7/1/2024	NGO- Earth Justice	EJ	At full capacity, these pumps would push 16 billion gallons of water a day into an already flooded Yazoo River, increasing flood risks for highly vulnerable downstream communities that suffer from pervasive and systemic environmental injustices.	The potential downstream impacts of the proposed pumps were considered and modeled. The 25,000 cfs pump flow was added to the Yazoo River during the peak of the 2011 Mississippi River flood to see the increase stage at the Vicksburg gage. The model showed a maximum of 0.40 foot increase at the Vicksburg gage due to the added flow from the Yazoo Backwater Pumps. This increase in stage played out prior to the peak of the flow getting to the Natchez gage on the Mississippi River. During the 2011 Mississippi River flood, the USGS measured 2,300,000 cfs passing the Vicksburg gage during the peak of the flood in May. According to the rating curve, an additional 25,000 cfs would equate to approximately a 0.30 foot increase in stage. It is not anticiapted installation and implementation of the proposed water management solution would result in impacts to downstream communities. See Appendix H for additional details.
7	7/1/2024	NGO- Earth Justice	NEPA	We also note that the Corps has only provided placeholders for the following important appendices:App. B—Public Comments (which at this stage should provide scoping comments); App. C—State and Agency Comments (which at this stage should provide scoping comments); App. D-2—Fish and Wildlife Coordination Act Report; App. E— Programmatic Agreement; and App. G—Threatened and Endangered Species.	Comment noted. Appendices B, C, D-2, E, and G are finalized and incorporated into the FEIS.
8	7/1/2024	NGO- Earth Justice	Economics	The Corps also has not provided any assessment of project costs or benefits	Comment noted. Inclusion of a benefit:cost analysis to select an alternative or support a project action was not connducted or included in the DEIS.
9	7/1/2024	NGO- Earth Justice	NEPA	The Corps as not provided (or indicated that it has initiated) the required Independent External Peer Review.	The Corps was directed to develop an Environmental Impact Statement (EIS) for the final feature of the already authorized Yazoo Backwater project. This effort is not a feasibility or reevaluation report. Per ER 1165-2-217 (1 May 2021), "an IEPR is conducted on project studies. Project studies result in feasibility or reevaluation reports and include any other study associated with the modification of a water resources project that result in decision documents." The review plan for this EIS has received concurrence from the Flood Risk Management Planning Center of Expertise (FRM-PCX) that an IEPR is not required for this effort.
10	6/29/2024	General Public	General Support	We did live in Holly Bluff until 2019 and the flood took everything we had our trailer and everything in it and other people did too they need the pumps put in you are more worried about the birds people are losing their homes and businesses and wild animals are died because you will not put the pumps in if you would have lost your home then you would know Sent from my iPhone	See response to comment 1
11	7/1/2024	General Public	General Support	Have you seen the flooding in Minnesota? Some people are floating in their streets withh mire rain coming to the Midwest. Where do you think that water us coming? For God's sake, COMPLETE the Yazoo Backwater Project. Have you not learned anything from the six month flood of 2019? I have NO faith in USACE or any other U.S. government organization.	See response to comment 1
12	7/2/2024	General Public	General Support	I wish that I had kept count of how many times you have asked me for comments or how many meetings I have attended with you. Nothing has changed since the 2008 veto of this project or the devastating 2019 flood except that the flooding has gotten more frequent, longer in duration.The devastation to the residents, environment and wildlife did not have to happen and should never happen again. The project has gotten more expensive every year that it has been delayed and that will be one of our opponents rational to stop it even though it is their fault! You have heard our stories, seen our pictures and our tears. What you have not done is feel our pain.Stop wasting our time and money and finally finish the job you were tasked with doing over 40 years ago - finish the Yazoo Backwater Pump Project.	See response to comment 1
13	7/1/2024	NGO-Healthy Gulf	NEPA	It requests a 45-day extension of the public comment period for the U.S. Army Corps of Engineers (Corps) Yazoo Backwater Area Water Management Project Draft Environmental Impact Statement (Draft EIS). The requested extension is critical for providing stakeholders and interested community members with a meaningful opportunity to review and comment on the Draft EIS.	See response to comment 4.
14	7/1/2024	NGO-Healthy Gulf	General Opposition	The Draft EIS recommends this highly controversial plan, proposing a pumping plant with the capacity to drain enough water from the Yazoo Backwater Area each day to fill more than 17 New Orleans' Superdomes, draining and damaging hemispherically significant wetlands.	See response to comment 5.
15	7/1/2024	NGO-Healthy Gulf	EJ	At full capacity, these pumps would push 16 billion gallons of water a day into an already flooded Yazoo River, increasing flood risks for highly vulnerable downstream communities that suffer from pervasive and systemic environmental injustices.	See response to comment 6.
16	7/1/2024	NGO-Healthy Gulf	NEPA	We also note that the Corps has only provided placeholders for the following important appendices: App. B—Public Comments (which at this stage should provide scoping comments); App. C—State and Agency Comments (which at this stage should provide scoping comments); App. D-2—Fish and Wildlife Coordination Act Report; App. E—Programmatic Agreement; and App. G—Threatened and Endangered Species.	See response to comment 7.
17	7/1/2024	NGO-Healthy Gulf	Economics (BC Ratio)	The Corps also has not provided any assessment of project costs or benefits	See response to comment 8.
18	7/1/2024	NGO-Healthy Gulf	NEPA	(The Corp) and has not provided the required Independent External Peer Review.	See response to comment 9.
19	7/1/2024	General Public	General Support	Our homes need those pumpes!!!! Put the pumps in !!!	See response to comment 1
20	7/1/2024	General Public	General Support	With the SCOTUS relying yesterday to guy "Chevron" the EPA power has been gutted. Build the pumps!	See response to comment 1
21	7/3/2024	General Public	General Support	With everything we went through in 2019 that should be enough for the government to step in and help.With the crops the the houses lost.We know there is a solution to the problem. Please finish the pumps Sent	See response to comment 1
22	7/3/2024	General Public	General Support	Please help us with the flooding issue. We have a home at 319 Sea Island Drive and can't afford to lose our home again due to flooding.	See response to comment 1
23	7/3/2024	General Public	General Support	How much study is still needed??? Studies have shown that this current plan will work Too many lives, livelihoods , wildlife etc have been affected by these floods Let's get the pumps approved and safe a beautiful area	See response to comment 1

Comment Number	Comment Date	Org.	Theme	Comment	Response
24	7/3/2024	General Public	General Support	Ladies and gentlemen of the Corps, Department of Interior, Game and Fish and EPA, I am writing again to ask that you please finish the flood control project that has been studied and approved off again and on again to protect our communities. It seems whatever concessions we make, whatever we give up, the special interest groups will attack us. I have been to all of the meetings held on the pump project. I have written several emails, filled out cards, sat at tables explaining the problem of the "no pump" solution. The last meeting at the COE offices in Vicksburg we were told by the department representatives they and you will fight for us. You saw the harm, the destruction, the injustices inflicted upon the communities, farmers, trees, wildlife, rivers, lakes, and the mental health of the thousands of people affected by not having the pumping project completed. Please, finish this project in my lifetime. This is such a beautiful place that is slowly being destroyed by an unnatural flood	See response to comment 1
25	7/3/2024	General Public	General Support	Our home is on Eagle Lake. It floods too when the trapped rain rises. The 100 year old cypress trees, the banks of the lake, our property(piers) are destroyed when this happens. There are dozens of large cypress trees dead or dying right now. We have NOT recovered because the flooding always hangs over our head every time the river rises and the gates close to trap rain in the Yazoo Backwater Area. When the rain begins, I begin to panic and anxiety because I know that what happened before, will happen again. This is a preventable disaster.	See response to comment 1
26	7/3/2024	General Public	General Support	The South Delta is not expendable. The USA needs our crops, our wildlife, our people. Stop listening to professional so-called environmentalists who have never lost a year of crops, worn waders inside their homes, watched wild animals starve day by day, or smelled the inescapable stench of rotting wildlife and native vegetation that they claim to care about. Backwater flooding is not a natural disaster threat. It's 100% manmade. And the remedy must be 100% manmade. After almost a century of federal mismanagement, IT'S TIME to FINISH The PUMPS! As a child I road the turn rows of my grandfather's land near Steele Bayou in Issaquena County. I watched him clear it, cultivate it, and harvest from it in the 1950s. I now am trustee and lease it to good stewards of this rich land that has had fallow years due to flooding. Environmental scientists have now verified what the folks living here have been saying for generations. Maybe you'll now listen to them instead of the environmental groups who distort and misrepresent the situation to pocket millions of dollars in contributions from gullible donors. Please protect our South Delta wildlife, our woodlands, our rich soil and livelihoods. Please keep your promise made 90 years ago. Install that last pump.	See response to comment 1
27	7/3/2024	General Public	General Support	To Whom it May Concern, I am writing in favor for the pumps. As a farmer and landowner near Onward, it will be of great help to those in the Backwater area. To many times floods have devastated wildlife, farms, and homes, and could've been prevented. Floods do not discriminate by race, religion, or gender. How many times over the last 75 years could the residents of the area been helped? Please put my comment down as a definitive "Yes".	See response to comment 1
28	7/3/2024	General Public	General Support	Good Afternoon, I hear that the CORE would like our comments again about the backwater flooding. Being only a resident of the South Delta since 2019, I can only voice my experiences of the last flood. It is my hope and prayer that the 'FINISH THE PUMPS" can be finished and put this long awaited, waste of time, resources to bed. Probably more money spent fighting over the pumps than it would have cost to just do the job. Thanks to the Vicksburg CORE for working with us.	See response to comment 1
29	7/3/2024	General Public	H+H	All the Eagle Lake residence were trying so hard to keep the water from coming over. We worked tirelessly sand bagging, pounding T post, strapping tin to them, helping people move their stuff to higher ground, trying to find alternate living arrangements. Then it still happened, 3 ft of water under our house, lost equipment, propane tank filled so no water. We survived it, the wildlife didn't fare so well, if the deer didn't get hit but vehicles, they starved or drowned looking for somewhere to go. Rerouting our commute over an hour detour and still had to be very careful, the levee was not built handle everyday traffic.	See response to comment 1
30	7/3/2024	General Public	General Support	It is time to finish this project, the South Delta cannot take another flood like we had in 19… please, the animals or people cannot survive with another 9 month flood, I live here, work here and my family has been here since 1947… Thanks Jeff Terry	See response to comment 1
31	7/3/2024	NGO-Audobon Society	NEPA	Dear Col. Gipson and Mr. Renacker: On behalf of the National Audubon Society and our more than 1.6 million members, including nearly 38,000 members in our Audubon Delta region (AR, LA, MS), we respectfully request a 45-day extension of the public comment period for the U.S. Army Corps of Engineers' (Corps) Yazoo Backwater Area Water Management Project Draft Environmental Impact Statement (EIS). The requested extension is crucial to ensure that our members, impacted communities, and other interested stakeholders have a meaningful opportunity to review and comment on the Draft EIS. Interested stakeholders like ours require additional time to review and analyze the information that has been posted, obtain and review the missing information, and prepare informed comments. For these reasons, Audubon respectfully requests a 45-day extension of the comment period, so that our members and the public will have a total of 90 days to review the Draft EIS and provide comments. Thank you for considering our urgent request. We look forward to your prompt response.	See response to comment 4.
32	7/3/2024	NGO-Audobon Society	General Opposition	As the Corps is aware, dozens of local community members and more than 130 conservation and social justice organizations submitted letters opposing the Corps' preliminary Yazoo Pumps proposal the during the 2023 scoping phase of the Draft EIS. This opposition was based on the project's significant threat to the area's hemispherically important wetlands and vulnerable communities	See response to comments 5 and 6.
33	7/3/2024	NGO-Audobon Society	EJ	The Draft EIS recommends this highly controversial plan that would drain and damage hemispherically significant wetlands and pose increased flood risks for highly vulnerable downstream and backwater communities that suffer from pervasive and systemic environmental injustices	See response to comment 5 and 6.
34	7/3/2024	NGO-Audobon Society	NEPA	Given these serious concerns, interested stakeholders require additional time to review and analyze the information in the more than 920 pages included in the Draft EIS and multiple technical appendices. We also note that the Corps has only provided placeholders for the following important appendices: Appendix B—Public Comments (scoping comments should be provided at this stage); Appendix C—State and Agency Comments (scoping comments should be provided at this stage); Appendix D-2—Fish and Wildlife Coordination Act Report; Appendix E—Programmatic Agreement; and Appendix G—Threatened and Endangered Species.	See response to comments 4, 5, and 7.
35	7/3/2024	NGO-Audobon Society	Economics (CB Ratio)	Additionally, the Corps has not provided any assessment of project costs or benefits nor has it provided	See response to comment 8.
36	7/3/2024	NGO-Audobon Society	NEPA	provided—or indicated that it has initiated—the required Independent External Peer Review.	See response to comment 9.
37	7/3/2024	General Public	General Support	Eagle Lake is first about the kind and helpful people and next all about the very generous natural beauty of its expansive environment. Wildlife, flora, and fauna here are abundantly enjoyed despite repeated past flood events. During the floods, though we lived elsewhere, we knew the people here withstood the stress and hardship of repeated flood-induced personal health issues, suffered humane treatment from outsiders looking in, feared for their safety, and suffered undue financial burdens. We always found ourselves just shocked to disbelief of the opposition from the government and from several groups that promoted decisions of hurtful nature to human life and happiness of the people who are overly affected by the repeated flooding. Shameful actions have been made towards humans who work, and pay for the right to have a life lived in peace. We had a strong desire to live the Mississippi delta life, and still remain near the interstate, air, train, and other means of transportation in our retirement years. The Eagle Lake area is and provides all of these things. In October, 2020 we purchased this home and property in the Eagle Lake / northwest Warren County community as our new full time residence. We are fortunate to have found a home situated inside the Brunswick levee area, which has prevented the house structure from flood damages in 2019 and prior flood years. The land and buildings we have on the lake side of the Brunswick levee, however, did have serious water erosion damage from floods (suffered and repaired by the previous owners). Obviously we never want to find ourselves being affected by any flooding. We seek to fully support doing the right thing of building the extremely overdue and overlooked structures to alleviate major long term flood damage in the Mississippi Delta. We support correcting the many past wrongs. This pump structure is right, it is doable, and it is expected and anticipated by everyone of us who desire an end to being ignored by they whose job it is to make sound honest humane decisions.	See response to comment 1

Comment Number	Comment Date	Org.	Theme	Comment	Response
38	7/3/2024	General Public	Wetlands	The Big Sunflower and Yazoo Rivers are home to some of the richest wetland and aquatic resources in the nation, and support more than 450 species of birds, fish, and wildlife. But these rivers are already in crisis. More than 80 percent of wetlands and native forests in the Lower Mississippi alluvial floodplain have already been lost, and the Supreme Court's recent Sackett decision endangers more than half of our nation's remaining wetlands. In addition, agricultural practices and water withdrawals are wreaking havoc on river health. Now is the time to protect the ecologically vital Yazoo Backwater, not to put it at even greater risk.	See response to comment 5.
39	7/3/2024	General Public	EJ	Not only would the proposal hurt the environment but the pumps would provide little flood protection for local communities and could worsen downstream flooding in marginalized Black communities.	Comment noted. Compensatory mitigation has been proposed to offset anticipated habitat units. Flood protection provided by the proposed water management solution would protect 759 residential structures that would be subject to 2019 flood levels. Additionally, see response to comment 6 and 7. See also that the project complies with relevant Executive Orders and the Justice40 Initiative.
40	7/3/2024	General Public	Economics	The Yazoo Pumps project would cost more than $1 billion and do little to protect communities from flooding. Eighty-three percent of the land that flooded during the 2019 flood event would still have been underwater if the Pumps had been in place.	Comment noted. Flood protection provided by the proposed water management solution would project 759 residential structures that would be subjuect to 2019 flood levels. Additionally, see response to comments 6 and 9.
41	7/4/2024	General Public	General Support	Hello, My husband and myself are full time residents of Eagle Lake in northern Warren County, MS., we have lived here for 27 yrs and love were we live. We have been through flooding of our area numerous times, and a few times it was severe enough for residents to evacuate. One time we lived at a hotel in Vicksburg for an entire month until we could move back home to Eagle Lake, yes it is frustrating and stressful, some residents move away, but we continue to stay here cause we love where we live, we enjoy the wildlife also. We have also seen wildlife dying along the road and in residents yards from the severe flooding. We have needed this pump for many, many, many years. There is no excuse as why we can not have the Yazoo Backwater Pumps. Mississippi is the only state along the river that DOESNT have any pumps !! Politics should not be an excuse either. The folks that continue to block the pumps would not appreciate it if their own families were subject to flood and need the pumps. People that continue to block the pumps are killing the wildlife and could drown residents in a flood, Please help your fellow man and install the PUMPS today !!!!!!!!!!!!	See response to comment 1
42	7/4/2024	General Public	General Support	Farmers cant work and lose money that is suppose to support their families. they are also taking money from farmers and their families if they cant farm. Mississippi is already a poverty state, why continue to enable that by letting residents get flooded out of their homes?	See response to comment 1
43	7/4/2024	General Public	General Support	I am for the pumps! Let's protect our families, productive farmland and wildlife from future flooding! Build the pumps!	See response to comment 1
44	7/4/2024	NGO-Mississsippi Sierra Club	NEPA	Dear Col. Gipson and Mr. Renacker: On behalf of our 2,000+ members in Mississippi, the Mississippi Sierra Club respectfully requests a 45-day extension of the public comment period for the U.S. Army Corps of Engineers' (Corps) Yazoo Backwater Area Water Management Project Draft Environmental Impact Statement (EIS). The requested extension is crucial to ensure that our members, impacted communities, and other interested stakeholders have a meaningful opportunity to review and comment on the Draft EIS. Given these serious concerns, interested stakeholders require additional time to review and analyze the information in the 920+ pages included in the Draft EIS and multiple appendices. For these reasons, we respectfully request a 45-day extension of the comment period, so that our members and the public will have a total of 90 days to review the Draft EIS and provide comments. Thank you for considering our urgent request and we look forward to your prompt response	See response to comment 4.
45	7/4/2024	NGO-Mississsippi Sierra Club	General Opposition	During the 2023 scoping phase of the Corps' Draft EIS for a preliminary Yazoo Pumps proposal, dozens of local community members and more than 130 conservation and social justice organizations submitted letters opposing the project's significant threat to hemispherically important wetlands and vulnerable communities. The Draft EIS recommends this highly controversial plan that would drain and damage hemispherically significant wetlands	USACE utlized an HGM assessment to forecast potential wetland impacts as a result of water management alternatives within the Yazoo Study Area. The HGM model used to assess impacts has been independently reviewed prior to conducting the analysis and is certified for use in civil works projects. Mitigation is proposed to compensate for lost ecological function/habitat value impacted by the project.
46	7/4/2024	NGO-Mississsippi Sierra Club	EJ	and pose increased flood risks for highly vulnerable downstream and backwater communities that suffer from pervasive and systemic environmental injustices.	See response to comment 6.
47	7/4/2024	NGO-Mississsippi Sierra Club	NEPA	Notably, the Corps has only provided placeholders for numerous important appendices: Appendix B—Public Comments (scoping comments should be provided at this stage); Appendix C—State and Agency Comments (scoping comments should be provided at this stage); Appendix D-2—Fish and Wildlife Coordination Act Report; Appendix E—Programmatic Agreement; and Appendix G— Threatened and Endangered Species.	See response to comment 7.
48	7/4/2024	NGO-Mississsippi Sierra Club	Economics (CB Ratio)	Additionally, the Corps has not provided any assessment of project costs or benefits	See response to comment 8.
49	7/4/2024	NGO-Mississsippi Sierra Club	NEPA	nor has it provided—or indicated that it has initiated—the required Independent External Peer Review.	See response to comment 9.
50	7/5/2024	General Public	General Support	These pumps are crucial for the environment and human safety! Finish the pumps please!	See response to comment 1
51	7/5/2024	General Public	General Support	I have lived in Eagle Lake, Mississippi now for 15 years. In those 15 years, I have had to leave my house 3 times. Out of the 3 times, twice I've had to pack my belongings. My husband's job is at Eagle Lake. He doesn't get paid if he doesn't work which in turn, our bills don't get paid. I now work at Eagle Lake, as we both work for Tara Wildlife. This effects people's lives and jobs. People can't get medical attention, get medicine, buy food, get to church when they are surrounded by water every way they turn. We have fought for years over the pumps and struggled with leadership that don't give a damn about us. We count... help us get this done. It's time.... Finish the Pumps.	See response to comment 1
52	7/5/2024	General Public	General Support	This is Luke Richards from Yazoo City, MS I work in the south MS Delta as a Crop Consultant around Rolling fork and Humphreys county. I grew up out on Wolf Lake which is between the Whittington Channel and the Yazoo River so not in the area being discussed but most of my career is in the backwater area. I fully support the pumps and we need them if we want to have any economic future in the area. To change the subject slightly I am only 24 years old and have experienced 5 floods that got in my parents house (08, 11, 15-16, 18-19) and hope this would help relieve that problem somewhat. I know there's been talks about finishing the Yazoo river levee and I support that as well. Needs to be done to protect our natural environment These floods are awful for the wildlife in our area. The deer, rabbits, turkey and everything else suffer immensely during these events. This includes starving, getting hit by cars and an increase in disease pressure due to being clumped together so tightly on high ground. The water also gets far too deep for waterfowl to enjoy. This project would let us control the water and be so beneficial for everyone involved not just us humans That's really all I have to say. If this project doesn't happen the south delta will eventually be an unpopulated region except for seasonal migrant labor and people too poor to move. We will lose an area rich in culture if something doesn't change. Thank you for your time I hope you read this far	See response to comment 1
53	7/8/2024	NGO- National Wildlife Federation	NEPA	On behalf of our millions of members and supporters, the National Wildlife Federation requests a 45-day extension of the public comment period for the U.S. Army Corps of Engineers (Corps) Yazoo Backwater Area Water Management Project Draft Environmental Impact Statement (Draft EIS). The requested extension is critical for providing stakeholders and interested community members with a meaningful opportunity to review and comment on the Draft EIS	See response to comment 4.
54	7/8/2024	NGO- National Wildlife Federation	General Opposition	As the Corps is aware, dozens of local community members and more than 130 conservation and social justice organizations submitted letters opposing the Corps' preliminary proposal for the Yazoo Pumps during the during the scoping phase of the Draft EIS. This opposition was based on the project's significant threat to the region's hemispherically significant wetlands and vulnerable communities. The Draft EIS recommends this highly controversial plan, proposing a pumping plant with the capacity to drain enough water from the Yazoo Backwater Area each day to fill more than 17 New Orleans' Superdomes, draining and damaging hemispherically significant wetlands. At full capacity, these pumps would push 16 billion gallons of water a day into an already flooded Yazoo River, increasing flood risks for highly vulnerable downstream communities that suffer from pervasive and systemic environmental injustices.	See response to comments 5 and 6..

Comment Number	Comment Date	Org.	Theme	Comment	Response
55	7/8/2024	NGO- National Wildlife Federation	General Opposition	Given these highly significant risks, interested stakeholders require additional time to review and analyze the information in the more than 920 pages included in the Draft EIS and multiple technical appendices. We also note that the Corps has only provided placeholders for the following important appendices: App. B—Public Comments (which at this stage should provide scoping comments); App. C—State and Agency Comments (which at this stage should provide scoping comments); App. D-2—Fish and Wildlife Coordination Act Report; App. E—Programmatic Agreement; and App. G—Threatened and Endangered Species. The Corps also has not provided any assessment of project costs or benefits and has not provided (or indicated that it has initiated) the required Independent External Peer Review.	See response to comment 4.
56	7/3/2024	General Public	Alternatives	We farm on the east side of the yazoo river in humphreys county. There is a section of the levee around Tchula Mississippi that was never completed back wher the levee was built. Is there anyplan to finally finish it? Why was it never completed? This is the cause of a lot of backwater	Comment noted. However, the referenced area is located is outside of the federal levee system.
57	7/10/2024	General Public	General Support	I am a 5th generation Vicksburger and 2nd generation owner of property on the bank of Eagle Lake. I remember when the Yazoo backwater project began and watched dirt being moved and concrete being poured. I also remember how excited we were to have the Federal Government helping us to keep from flooding Needless to say, myself and many others that utilize the Yazoo Basin have been highly disappointed and have suffered many hardships from flooding that could have been prevented if only this project had been completed! I served for 24 years as a County Supervisor in Warren County MS and I am completely shocked that our Federal Elected officials and their minions would let outside special interest groups sway them to not complete such an important flood prevention project. Please do not hesitate any longer to finish this project and install the pumps!	See response to comment 1
58	7/11/2024	General Public	General Support	The flood was devastating for a lot of people that didn't deserve any of it. My family's homestead was flooded and had to remodel the family home. My sister & her family live in that home now. The pumps need to be completed so the flooding never happens again to disrupt people's livelihoods. The wildlife was displaced just like the families that live there. Please finish the pumps!! Sent from my iPhone	See response to comment 1
59	7/12/2024	General Public	General Support	I'm a landowner in the Yazoo Backwater Study Area and enthusiast for the >200,000 acres of public lands listed in Table 4-8 of the EIS report. I've enjoyed hunting, fishing, and other activities on these areas and the waterways within the Yazoo Basin for 20+ years and sustainability of these resources is very important to me, my family, and many friends. Over the years we have seen firsthand declinesin many aspects, and it is very concerning to us. This project has the potential to reverse those trends, so we are very interested and excited about how it could impact the area in a positive manner. See below	See response to comment 1
60	7/12/2024	General Public	Mitigation	On page 10 of the main EIS report, it is mentioned that four green tree reservoirs (GTRs) were completed by the MVK in the Delta National Forest in the late 1970s and early 1980s to mitigate fish and wildlife losses resulting from flood control works that were part of the earlier stages of the Yazoo Backwater Project. It also states that the GTRs and the slough control structures are not being operated by the U.S. Forest Service (USFS), nor are they being maintained by the MVK. This differs from the Yazoo Backwater Area Reformulation report that was published in October 2007 in where it is stated on page 7 of that report that the existing (4) GTRs were being operated by the USDA Forest Service and maintained by MVK. What has changed between now and 2007? Are the GTRs and slough control structures being operated and maintained by another party? If yes, can you please include those details in the report since they pertain to the sustainability of mitigation for past MVK actions associated the overarching Yazoo Backwater Project? If the claim is that the GTRs are still providing mitigation as originally planned in 1976, please provide additional details on how the (4) existing GTRs were operated over the past 10 years including the flood schedules and at what pool levels they were flooded to ensure an adequate wetland function and habitat for wildlife including waterfowl. If the GTRs are no longer in operation or maintained as originally planned in 1976, allowing prior Yazoo Backwater Project mitigation efforts to expire or cease operations without additional offsets doesn't seem like a sustainable plan, and it doesn't seem like it's in the best interest of the wildlife or for future generations to enjoy the benefits provided for public use. It would also contradict how the backwater levee system is operated and maintained (see section 1.2 on page 4 where it is stated that operation and maintenance of the levees are the responsibility of the Federal government). If this is the case, backlogged mitigation requirements for already constructed portions of the overarching Yazoo Backwater project should be accounted for in the current mitigation proposal and water management plan associated with this phase of the project, which is contrary to what is stated in the second paragraph on page 12 of the main EIS report.	Comment noted. The project features for which the green tree reserviors were created never constructed and USACE ceased operations in approximately 2010
61	7/12/2024	General Public	H+H	On page 24 of the main EIS report, there is mention of modeling data showing that a 25,000 cfs pump would have taken 8 days to draw the water down from 98 feet to 97 feet during the 2019 flood. It is then stated that the calculation can be extrapolated to indicate that it would take up to 24 days to draw the water down from 93 feet to 90 feet (8 days per foot multiplied by 3 feet). That math appears to be too simplistic and short sighted ignoring the fact that the surface area and volume of water in the Yazoo Backwater Area would be different at 98 feet versus 93 feet. MVK should consider developing an expected draw down period that is supported by modeling data relevant to 93 feet to accurately calculate the duration of pumping required to reduce the level to 90 feet which would provide a stronger technical rationale to support the dates chosen for the crop and non-crop season dates in Alternative 2.	Comment noted. How fast the water drops in the Yazoo Backwater is solely dependent on how fast the MS River drops. USACE is providing a range or an average, and not an expected draw down due to this fact.For example, even though 2019 was a worse flood than 2020, the 2019 event would have drained out quicker than 2020 in a with-pump scenario. Under this scenario, the water would have reached 93.5' on 16 March and would be down to 90' on 12 April. That was 27 days to drop 3.5' - an average of 7.71 days per foot. In 2020, the water would have reached 93' on 1 March and would be down to 90' on 26 March. That was 26 days to drop 3'. Average of 8.67 days per foot. Therefore, a flood that was 2' lower took a day longer, per foot, to drain down to 90'. Similarly, for 1997, floodwaters would have dropped about 1' every 6 days. Therefore, a range is a more appropriate description than an expected draw down.
62	7/12/2024	General Public	H+H	Context should be added to sections 3.3.2.1 and 3.3.2.2 on pages 32 thru 35 of the main EIS report to explain the functionality of the pumps during a Project Design Flood event where the backwater levee systems are overtopped by design (as explained on page 84 of the main EIS report). It seems like the pumps would provide additional flexibility to get floodwater off lands above the 5-year floodplain in an expedited manner rather than being at the mercy of the Mississippi River and relying on it to drop >14 feet post crest before floodwaters could recede below the 5-year floodplain via the Steele Bayou WCS. While an event like this has not occurred to date, it should be considered when weighing the benefits of each alternative since there was a near miss during the May 2011 Mississippi River flood event where the riverside gage at the Steele Bayou WCS reached 106.2 feet and was just a few inches from overtopping the backwater levee system (as explained on page 86 of the main EIS report).	Comment Noted. The water management plan has been thoroughly examined and reviewed. We have looked at what would occur during a PDF event but the process still remains the same. We will have to wait until we get a 90' or 93' at Steele Bayou (depending on crop or non-crop season) to operate the pumps. We would also have to wait until the peak of the overtopping has occurred and water recedes back down below the top of the backwater levee. The backwater levee is designed to overtop by approximately 1.5' during a PDF event and it doesn't make sense to pump water while the backwater levee is still being overtopped. We also have to factor in the pump operation guidance and that has to do with what the interior elevations are. Each flood event will be different. During the 2011 flood, the MS River floodwaters did get within inches of overtopping the backwater levee. However, we were fairly dry on the interior (Yazoo Backwater) and never reached 90' elevation. We would have been in crop season so at the point the water overtopped the backwater levee and the interior reached 90' then we could turn on the pumps. Also we will not run the pumps and Steele Bayou at the same time. With head on the Steele Bayou structure, it can evacuate about twice the amount the pumps can. We would turn on the pumps and manage to 90' and then when water recedes to a level where we can open Steele Bayou, the gates would be opened and the pumps would be turned off.
63	7/12/2024	General Public	Economics	In section 3.6.9 on page 45 of the main EIS report, would the maintenance plan for the low flow wells be susceptible to MVK budget cuts? If so, acknowledging that functionality, mitigation efforts, and potential additional environmental impacts would be exposed to federal budget cuts in the future should be considered in this section.	Comment Noted. MVK would continue to express capability for operation and maintenance of the low flow wells.
64	7/12/2024	General Public	me and Unique Farmla	On page 106 of the main EIS report, the intro statement for the "Alternatives 2 and 3" section is attempting to explain the differences between the two alternatives but is not accurate. The intro statement should be corrected to point to the differences between the two alternatives (season dates only).	Comment noted.
65	7/12/2024	General Public	Alternatives	In section 5.1.3 on page 112 of the main EIS report, there should be consideration for adding a cross reference to section 4.2.1.3 under the No Action Alternative. As-is, it can be read out of context that no impacts to farmland would occur. Having this section point back to the Farmland Protection Policy Act should provide clarity on what is being stated.	Comment noted and clarified.
66	7/12/2024	General Public	Mitigation	On page 121 of the main EIS report, under the No Action Alternative it is stated that project related impacts to recreational resources would not be expected. This conflicts with some of the things that are stated on section 4.2.1.5. In Table 4-8, Howard Miller WMA and Mahannah WMA are listed as susceptible to backwater flooding but also as managed for waterfowl. Waterfowl management on the South Delta WMAs typically involves the planting of crops or moist soil management and both hinge on the ability to control water levels within the managed impoundments during certain times of the year. You should consult with MDWFP's waterfowl biologists to ensure they agree that future waterfowl management practices would not be exposed to potential interruption with Alternative 1 or Alternative 4, as they were during the spring and summer months of 2019 and 2020. Conversely, I would expect the nonstructural features of Alternatives 2 and 3 to have a positive impact on the waterfowl management practices at Howard Miller WMA and Mahannah WMA as MDWFP would then have full control of water levels on the managed units above the 5-year floodplain throughout the year and especially during the growing season for crops and moist soil plants within the 2-year floodplain.	Comment noted. However the timing of flooding, most often occurring in the spring, and waterfowl hunting season, occuring in the fall are unlikely to overlap. Additionally, spring floods are likely to benefit migratory waterfowl as evidenced by results shown in the DUD model.

Comment Number	Comment Date	Org.	Theme	Comment	Response
67	7/12/2024	General Public	Wildlife	In section 5.2.4 on page 142 of the main EIS report, it is stated that there would be no direct impact to wildlife for Alternative 1. This is another instance that may require additional coordination with MDWFP biologists to ensure impacts from unimpeded backwater flooding above the 5-year floodplain are captured correctly within the EIS report. For example, it is a known fact publicized by MDWFP that the turkey population in the Yazoo Backwater Area was severely impacted by the flooding events over the past 10 years. As a result, turkey hunting has been closed by the MDWFP at most of the WMAs listed in Table 4-8 since 2016 to counteract the impact of the uncontrolled long duration flood events in the Yazoo Backwater Area.	Comment noted. However, disturbance events, such as flooding, provides important ecological benefits and maintains the habitat which is capable of supporting wildlife. To assess potential impacts and benefits from proposed project alternatives, a suite of environmental models were used. Under all proposed alternatives which reduced the frequency and duration of flooding to suitable habitat these models indicated environmental impacts would be incurred. Compensatory mitigation has been proposed to offset these losses.
68	7/12/2024	General Public	Alternatives	In section 5.2.5 on page 143 of the main EIS report, it should say the YSA currently provides an average of 6,571,178 DUD instead of 202,798 under the No Action Alternative to align with what is stated on page II of Appendix F-5. There is also a difference in how the No Action alternative is referenced in the main report versus Appendix F-5. The main report labels the No Action alternative as "Alternative 1" whereas Appendix F-5 does not label the No Action alternative but does label "Alternative 3" from the main report as "Action Alt 1". These labeling differences should be cleaned up in the final report to aid readers with cross referencing between the main report and Appendix F-5.	Concur, DUDs for the no-action alternative have been corrected.
69	7/12/2024	General Public	Alternatives	In section 5.2.5 on page 143 of the main EIS report, it should say the YSA currently provides an average of 6,571,178 DUD instead of 202,798 under the No Action Alternative to align with what is stated on page II of Appendix F-5. There is also a difference in how the No Action alternative is referenced in the main report versus Appendix F-5. The main report labels the No Action alternative as "Alternative 1" whereas Appendix F-5 does not label the No Action alternative but does label "Alternative 3" from the main report as "Action Alt 1". These labeling differences should be cleaned up in the final report to aid readers with cross referencing between the main report and Appendix F-5.	See response to comment 68
70	7/12/2024	General Public	T&ES	In sections 5.2.7 and 5.2.8 of the main EIS report, consider adding statements under Alternative 2 and Alternative 3 that the pump will provide opportunities for adaptive management to consider modifications to the Yazoo Backwater Area's water management plan such as the noncrop season inflow gate closure threshold for the Steele Bayou WCS which could increase connectivity with the Yazoo and Mississippi River systems and provide additional benefits to the aquatic resources, fisheries, and water quality. Having increased connectivity between the floodplain and the Mississippi River should also benefit the wildlife and fisheries as well as the threatened and endangered species described in section 4.2.2.6.	Comment noted. However, please note the fisheries spawning and rearing periods used for impact/benefit analysis have limited overlap with the non-crop season.
71	7/12/2024	General Public	H+H	Appendix F-4 and Appendix J have conflicting land coverage areas listed for the 90 ft and 93 ft elevations. Table A-7 of Appendix F-4 lists 136,133 acres and 224,779 acres for the coverage area at 90 feet and 93 feet respectively. Table 2 of Appendix J lists 148,553 acres and 244,088 acres for the coverage area at 90 feet and 93 feet respectively. Is there an explanation for the differences in the data sets that can be included in the final EIS report?	Comment noted, the difference is likely attributed to the use of both HEC-RAS model and FESM GIS tool used in analysis. However, both are used consistently in each respective resource.
72	7/12/2024	General Public	Gate Operations	Table 3 of Appendix J is misleading as the calculations for Alternative 2 and Alternative 3 assume that the 1985 Water Control Manual remains unchanged for the Yazoo Backwater Area, which results in "unavoidable" fish and wildlife habitat impacts. There should be further investigation by MVK to understand how conceptual changes to the legacy water management plan can reduce the impact to fish and wildlife before the EIS report is finalized and an alternative is recommended. An example would be adjustments to the inflow gate closure threshold(s) at the Steele Bayou WCS as soon as the pumps are installed and available for operation.	Comment noted. Alternatives 2 and 3 will include an operational plan that optimizes the potential for inter-basin water exchange improving reaeration in the lower Yazoo basin and benefits fisheries exchange. During potential flood-prone periods with rising Mississippi and Yazoo rivers, the operations plan for the Steele Bayou Water Control Structure (WCS) would allow free movement of water into and out of the lower Yazoo Basin up to an elevation of 75.0 feet, NGVD29 before closing the gate. This full utilization of the current Water Control Manual (1985) for the operation of Steele Bayou WCS will promote fishery species diversification. During low-water periods, the operation plan of the Steele Bayou WCS is currently operated to maintain water elevations between 68.5 and 70.0 feet, NGVD29, and this will continue.
73	7/12/2024	General Public	Mitigation	Section 10.3 of Appendix J recommends the purchase of agricultural lands to offset the impacts to shorebirds. The purchase of agriculture land seems like an extreme measure in this case. MVK and MDWFP should consider partnering with willing landowners and corn/soybean farmers to set up a program like what the Arkansas Game and Fish Commission has done with their WRICE program. This would also have benefits to waterfowl and a positive impact on DUD during the winter waterfowl migration season and help provide a long-term path for meeting the Lower Mississippi Valley Joint Venture population and habitat objectives detailed on page 4 of Appendix F-4. It could also be viewed as added recreational resources if the lands were open for public hunting, which could be captured as project benefits in section 5.1.5 or the main EIS report. Opportunities to increase waterfowl habitat within the Yazoo Backwater Area should carry heavy consideration due to fall tillage farming practices in the local area that may not be accurately accounted for in the DUD calculations that are detailed within Appendix F-4.	Comment noted. Please note that Measure 10 is recommended for shorebird mitigation, which is consistent with comment recommendation. Measure 10 is described as: Best Management Hydrology Practices for agricultural fields. This measure addresses the mitigation objectives by water retention during migratory bird period to benefit shorebirds and waterfowl. Numerous farmlands in the project area are managed for waterfowl during the waterfowl season, which require perimeter levees, water control devices, and water sources. A portion of these areas can be managed for shorebirds through inundation at depths that are suitable for shorebirds during the spring and fall migration periods. Additional agricultural areas could be purchased and water control devices, perimeter levees installed to allow for water management. Agricultural areas would be inundated during portions of the shorebird migratory period. Following the migratory period, the area would be planted for an agricultural commodity. Some agricultural techniques that require inundation, such as techniques for rice production may also be utilized to compensate for impacts if those techniques are complimentary to shorebird management.
74	7/12/2024	General Public	e Management and Mo	On page 7 of Appendix K, there is discussion on agricultural withdrawals from the alluvial aquifer for irrigation and the subsequent lowering of the water levels being one of the main contributors to the reduction in baseflow within the Yazoo Basin. Figure 1 then goes on to show that the lower baseflow trend abruptly started in the mid to late 1970's. Are there any statistics that can be provided to directly tie the significant change in the Yazoo Basin's baseflow to a significant uptick in agricultural irrigation withdraws during that same period? Also, does MVK have a perspective on the possibility of the Yazoo Backwater levee system being a likely culprit since that phase of the project was completed in 1978, as stated on page 1 of the main EIS report, which also coincides with the significant change in the baseflow trend? If there is acknowledgement of the levees possibly being a contributing factor due to reductions in connectivity with the Mississippi River, that should be included in the EIS report and used to strengthen the business case for the installation of the pumps and timely modifications to the water management plan to allow for increased connectivity to the Mississippi River once the pumps are in place. The water management plan could then be fine-tuned using the monitoring and adaptive management methodologies summarized throughout Appendix K.	Groundwater withdrawal permits (> 6" diameter) for use in agricultural irrigation, Aquaculture, or Fish and Wildlife Management within the Mississippi Delta area are submitted to Yazoo Mississippi Delta Joint Water Management District (YMD) for initial processing and sent to the Mississippi Department of Environmental Quality (MDEQ) Office of Land and Water Resources (OLWR) for final approval. If deemed acceptable, groundwater well permits are issued for five years when coupled with adequate conservation measures. YMD conducts water level surveys for the Mississippi River Valley Alluvial Aquifer (MRVAA) twice per year from over 500 monitoring well sites and maintains a real time monitoring network from approximately 10 monitoring well sites within the Mississippi Delta. An interagency collaborative team for the state of Mississippi has been working to address the declining water levels in the MRVAA for over a decade, the team includes representatives from YMD, MDEQ, and USGS among others. USGS has produced multiple professional papers describing the issues across the 5 state region of the MRVAA: Groundwater-flow assessment of the Mississippi River Valley alluvial aquifer of northeastern Arkansas - Scientific Investigation Report 2010-5210 Hydrology of the Mississippi River Valley alluvial aquifer, south- central United States — A preliminary assessment of the regional flow system - Water-Resource Investigations Report 88-4028 Hydrology of the Mississippi River valley alluvial aquifer, south-central United States - 1416-D USGS and MDEQ are also working to refine a working groundwater model for the MRVAA within the Mississippi Delta. The declining water levels in the YBA are actively being studied by other state and federal agencies. Federal authorization for the monitoring and use of groundwater resources in the YBA is currently granted to USGS and ARS (in limited farming application). Therefore, USACE does not have federal jurisdiction in the management of groundwater in the U.S. and thus limited in its ability to update or fund groundwater resource plans or studies in conjunction with the YBA Water Management Plan.
75	7/12/2024	General Public	Gate Operations	General Comment #1: The non-structural benefits provided by Alternative 2 or Alternative 3 in the form of flexibility provided for adaptive management and potential modifications to the Yazoo Backwater Area's water management plan appear to be understated and undervalued throughout the report. An example would be adjustments to raise the inflow gate closure threshold at the Steele Bayou WCS to allow for more connectivity to the Mississippi River and less dependence on local rainfall to ensure seasonal flood pulses on the 2-year and 5-year flood plains that would be closer to what was experienced before the earlier stages of the Yazoo Backwater Project were implemented in 1976. The comparisons to the no action Alternative 1 and non-structural Alternative 4 would be much more favorable for the pump alternatives if this was at least clearly put into context. It is understood that raising the inflow gate closure threshold would create more dependence on the pumps throughout the year and raise arguments about emissions associated with the generators but that can be countered with the fact that the mitigation plan involves wetland reforestation that would easily net out the increase in emissions through carbon sequestration.	See response to comment 72.
76	7/12/2024	General Public	Mitigation	General Comment #2: I agree that priority should be given to mitigation opportunities adjacent to public lands as listed in section 6.2 of Appendix J since most forested wetlands above the 5-year floodplain that would be impacted by Alternative 2 and Alternative 3 are existing public lands. This would also align with the preference for large contiguous tracts that is described on page 15 of Appendix J.	Comment noted and relayed to our partners working the In Lieu Fee program

Comment Number	Comment Date	Org.	Theme	Comment	Response
77	7/12/2024	General Public	Economics	General Comment #3: Will the O&M costs associated with the safe and reliable operation of the pumps in Alternative 2 and Alternative 3 be susceptible to MVK budget cuts? If so, acknowledging that functionality would be exposed to federal budget cuts during the life of the project should be considered for inclusion in Table 13 of Appendix J under the Operations Phase.	See response to comment 63.
78	7/12/2024	General Public	Mitigation	General Comment #4: Section 8 of Appendix J lists many alternatives for mitigation that are either out of state (Arkansas and Louisiana) or outside of the YSA. Mitigation alternatives that include activities outside of the Yazoo Backwater Area should be considered for screening because they don't meet the needs for the immediate area where the project impacts are occurring.	Comment noted. Sites that are not Spanish Fort Corridor, West, East, and Blues Highway were screend
79	7/12/2024	General Public	Gate Operations	General Comment #5: Once the pumps are in place, the 1985 Water Control Manual for the operation of the Steele Bayou WCS will become obsolete as that plan did not account for the pumps. The manual should be considered for updating in a timely manner and changes to the Steele Bayou WCS closure threshold(s implemented as soon as the pumps are available for operation.	Comment noted, the water control manual will be updated.
80	7/12/2024	General Public	Gate operations	General Comment #6: The full utilization of Water Control Manual (1985) for operation of the Steele Bayou WCS is mentioned (5) times throughout the main EIS report but I was not able to locate the manual during a search of the internet. The manual should be included as an appendix so that the public can reference it to understand what "full utilization" implies.	Comment noted. However, the water control manual will not be presented in the final EIS for legal and security purposes.
81	7/12/2024	General Public	Aquatics	General Comment #7: The project page where the draft EIS was posted mentions that the proposed plan allows for "increased fisheries exchange to the backwater area". It is not clearly explained how this is accomplished within the draft EIS report.	See response to comment 72.
82	7/12/2024	General Public	General Support	General Comment #8: I support Alternative 2 including the structural components of the pumps, if the existing 1985 Water Control Manual is reviewed and updated by the collaborating federal agencies in a timely manner, since that is in the best interest of wildlife and fisheries as well as the agriculture economy in the Yazoo Backwater Area. A solution that includes a pump station and robust water management plan is the right decision and would be consistent with how the other (3) backwater areas along the Lower Mississippi River are planned and operated. If a decision is made to pursue Alternative 1 or Alternative 4, it will neglect the needs of the residents in the Yazoo Backwater Area as well as continue to have a negative impact on wildlife and fisheries, which has been an issue for 46 years since the Yazoo Backwater Project was partially completed with levees, but pumps were never funded for construction. The time is right to have an overarching project in place that functions as originally planned for Mississippi. The states of Arkansas and Louisiana have been benefiting from their fully functional projects since 1977 (Huxtable pump station) and 1986 (Tensas-Cocodrie pump station) respectively.	See response to comment 1.
83	7/13/2024	General Public	General Support	To whom it may concern, I would like to encourage this group to go ahead and build the pumps. Here in Anguilla, MS, in Spring of 2019, I personally witnessed the difference having pumps on the Louisiana/Arkansas side of the river and the lack of pumps on the Mississippi side makes. I share some observations here. The most obvious is the way the river rose over farmland and homes, destroying homes, making travel to and from the homes left difficult or impossible. The water made it impossible for so many acres to be planted. I don't farm, but rent out some small number of acres, and the only rent I received that year was a small percentage of the small insurance payout that my renter received. That affected my bottom line and, of course, the farmer's. Many acres in the area were underwater so late that farmers were unable to plant, so they were even unable to receive insurance payments. They suffered badly. Another point that was really agonizing to witness was the negative affect on the wildlife and the vegetation. This should be of particular interest to groups that claim interest in the environment. Trees whose trunks and roots were under water for a long time died. Where the ground got spongy, some trees fell over for lack of support to their roots. At the time I had to travel north in the early mornings and saw many wild animals, deer, oppossum, raccoons, etc, running in the highway to get out of the water because the highway was higher ground. Of course, many were hit by vehicles. This was even worse going south towards Vicksburg, since the water was deeper and more widespread there. We also observed that many animals were skinny and starving since their source of food was under water or unplanted. I feel sure that if people and organizations who are concerned about wildlife had seen the devastation that year, they would realize the need of the pumps for the protection of the environment. They would see that withholding the pumps had the opposite effect that they support. Thank you for hearing my concerns and my thoughts on the need for the pumps. I hope that you will come around to seeing the need to complete this project. Sincerely, Rebecca Touchstone Diffey	See response to comment 1
84	7/15/2024	NGO- American Rivers	General Opposition	American Rivers requests a 45-day extension of the public comment period for the U.S. Army Corps of Engineers (Corps) Yazoo Backwater Area Water Management Project Draft Environmental Impact Statement (Draft EIS). This extension is crucial to provide all stakeholders, including community members and conservation organizations with relevant expertise, with sufficient time to meaningfully review the Draft EIS for the Yazoo Backwater. As the Corps is aware, the Draft EIS recommends a highly controversial plan, opposed by over 130 conservation groups and dozens of community stakeholders. At full capacity, the proposed pumps would push 16 billion gallons of water a day into an already flooded Yazoo River, increasing flood risks for highly vulnerable downstream communities that already suffer from pervasive and systemic environmental injustices.	See response to comments 4 and 5.
85	7/15/2024	NGO- American Rivers	General Opposition	Given the significant risks of a project of this magnitude, interested stakeholders require additional time to review and analyze the Draft EIS, which is more than 920 pages. Further, the Corps has only provided placeholders for the following appendices: App. B—Public Comments (should include scoping comments); App. C—State and Agency Comments (should scoping comments); App. D-2—Fish and Wildlife Coordination Act Report; App. E—Programmatic Agreement; and App. G—Threatened and Endangered Species. The Corps has also failed to provide any assessment of project costs or benefits and has not provided (or indicated that it has initiated) the required Independent External Peer Review. Stakeholders, including American Rivers, require additional time to review and analyze the information that has been posted, obtain and review the missing information, and prepare informed comments. For these reasons, American Rivers requests a 45-day extension of the comment period, so that the public will have a total of 90 days to review the Draft EIS and provide comments.	See response to comment 7.
86	7/14/2024	General Public	General Support	If you've ever driven through the area, it's pretty obvious from all the signs up that they want the pump stations built so the don't keep flooding	Comment noted
87	7/14/2024	General Public	General Support	Who do we contact about draining sky lake into the Yazoo. We need a new idiot in charge. Everyone trying to conserve water USACE Vicksburg District drains our most valued resources into drought lecels every year. Someone gotta do better.	Comment noted
88	7/16/2024	General Public	General Support	Tonight we joined the online meeting, and we fully support Alternative #2 When flooding occurs, it has been acknowledged that our homes, businesses, and property are in jeopardy. It should also be made clear in this YBW decision making process that our/the public's access to utility services and future improvement of public and private utility services such as: utility services from public water supply companies, land-line telephone companies, public and private electric companies, public and private natural gas service companies, as well as privately owned propane delivery service companies is severely limited due to the enduring lengthy flood waters. Repeated yearly flooding creates major loss o	See response to comment 1
89	7/16/2024	General Public	General Support	I would like to express my deepest concern for the finishing of the Yazoo Backwater Project. It's been ongoing for my entire lifetime and I cannot understand why it hasn't been completed yet. Even after the destruction of the 2019 flood. It's still not completed. The groundwork has been in place for years. Please finish this project and install the pumps to protect the residents of this affected area.	See response to comment 1
90	7/16/2024	General Public	General Support	I'd like to submit these comments concerning the DEIS of the Yazoo Backwater pump project. I'm a property owner in the south delta and was impacted by the floods of 2019 & 2020. The devastation caused by these floods to residents and property owners is well documented. The negative environmental impact on the wildlife, trees and land of the long duration of the flood has also been well documented. As the information in the federal register states, the Yazoo project is the only backwater project that was authorized that still does not have pumps built. It's time for the Federal Government to keep the promises made to the south delta and build the pumps. The national groups that are opposed to this project didn't witness first hand the devastation that we saw in 2019. They didn't drive the levees and see the large number of animals forced to live on the levees. They didn't see the loss of trees in later years due to the long duration of the flood. They didn't see residents forced to pack up and move out, not knowing when they would be able to come back, and what they would come back to, and they won't be there when it happens again. Prevent the next flood from having the impact on the region that occurred in 2019. Finish the pumps.	See response to comment 1. Additionally, models used to capture potential impacts and benefits to environmental resources conclude that a reduction of flood frequency and/or duration on suitable habitat results in impacts to resources which results in required compensatory mitigation.
91	7/16/2024	General Public	H&H	When I look at the alternative options and see the pool levels I am very concerned. The pool level at 90 feet is too high when we have big rains the gate or a pump can't keep up. The hunting season pool level at 93 is extremely too high. A lot of hunting land, gravel roads as well as hunting land that we pay high payments on or rent to hunt will be underwater. I recommend to lower these pool levels for all of us.	Comment noted. However, to balance competing interests (agricultural interests and primary residencies versus ecological value), alternatives were formulated with the goal of managing flood risks to agricultural lands and homes while at the same time recognizing the importance of flooding to the remaining natural environment. Although access may be limited on occasion, seasonal flooding maintains and provides ecological benefit to the natureal areas within the Yazoo Basin.
92	7/16/2024	General Public	General Support	As a 2019 flood survivor, I support Alternative # 2!	See response to comment 1
93	7/16/2024	General Public	General Support	We want to thank the EPA, the Corps and the U.S. Fish & Wildlife Service for working together to come up with a solution for our Backwater Flooding problem! We want Alternative 2 with a 25,000 cfs Pumping Plant that turns on at 90' starting March 16th each year.	See response to comment 1
94	7/16/2024	General Public	General Support	Alternative 2 appears to be the most logical solution. I support Alternative 2. Thank you.	See response to comment 1

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95	7/16/2024	General Public	General Support	Thank you for your time and effort in this project. As a 2019 backwater flood survivor I support alternative 2 and look forward to seeing this project completed.	See response to comment 1
96	7/16/2024	General Public	General Support	Alternative 2 appears to be the most logical solution. I support Alternative 2. Thank you.	See response to comment 1
97	7/16/2024	General Public	General Support	As a 29 year resident of Eagle Lake and one who stayed constant to the flood fight and hardships of the 2019 flood I support alternative 2.—	See response to comment 1
98	7/16/2024	General Public	General Support	As a 2019 flood survivor who was not able to return home for several months, I support Alternative 2.	See response to comment 1
99	7/16/2024	General Public	General Support	2019 flood survivors and we support alternative 2. Rhonda and Marty Hendrix	See response to comment 1
100	7/16/2024	General Public	General Support	Speaking in support of Alternative #2, as it will provide the highest level of avoidance of 2019/2022 events.	See response to comment 1
101	7/16/2024	General Public	General Support	I believe Alternative 2 is the best solution for our community.	See response to comment 1
102	7/18/2024	General Public	General Support	Just wanted to make a comment because I couldn't make it to the meeting today just to let you know that we need the pumps not only to benefit the farmers but to benefit the wildlife and the beauty of the land instead of selling dead timberland all the time after a flood just do what the government promised over 40 years ago and do the right thing and put the pumps in please	See response to comments 1, 113, and 503
103	7/18/2024	General Public	General Support	Please finish this project! It's been long overdue. Folks here need to be able to rest an not worry about flooding anymore Sent from my iPhone	See response to comment 1
104	7/21/2024	General Public	General Support	My letter is lengthy, but so was our suffering. On February 23, 2019 Hwy 465 closed disrupting access to homes and businesses at Eagle Lake. A Mandatory Evacuation Order for the Eagle Lake community was issued on either March 8 or 9th. As Low Water Bridge and access to Hwy 1 were inundated by backwater flooding the distance and hardship to get home or check on property increased. Full time residents were forced to either abandon their homes to live with relatives or friends, suffer costs of alternative housing or drive miles out of their way on poorly maintained roads to reach home and safeguard their property. We chose the latter while both still working. This commute added about 2 hours to our workday. I wish I could upload the hundreds of photos I have documenting this event. Below are excerpts from a diary of sorts that I kept in 2019: 2/23/19: Hwy 465 to Backwater/Mainline Levee closed. Day 1 of the disruption to our community. 3/4/10: Hwy 465 to the Gin and Eagle Lake Shore Rd (ELSR) closed. 3/8 or 3/9/19: Mandatory Evacuation Order issued 3/18/19: Backwater began seeping over areas of ELSR 3/23/19: Almost one month after Hwy 465 flooded, local residents began a massive sandbagging operation to protect homes and prevent the backwater from crossing ELSR and breaching Eagle Lake. Along with four other neighbors, we purchased our own pump and weeks of pumping backwater from our front yards back over the sandbags began. 4/4/19: Shortest route to Hwy 1 flooded by backwater, difficulty reaching homes and property increased. 4/9/19: Two layers of sandbags are holding the Backwater off ELSR and preventing the breach of Eagle Lake. 5/9/19: 47 days since the sandbagging effort began and 75 days since Hwy 465 flooded. Area residents, volunteers and inmates arranged by county law enforcement continue patching sandbags, adding layers and pumping backwater back into the field daily. Eagle Lake overtopped Muddy Bayou. We feel forgotten. The patients that I see and most of my colleagues have no idea what we are going through. 5/16/19: 54 days after the sandbagging of ELSR began, USACE brought an automatic sandbagger to the lake. Backwater (BW) 97.63' and Eagle Lake (EL) 92.82' 5/17/19: Waves and rising backwater begin to topple the 3-4 stacked sandbag levee on ELSR. Jim (my husband) and I fill three trailers with sandbags and place around our house to divert the impending backwater breach and slow the rush of water directly against our home. 5/18/19: White capped waves coming across the cornfield and backwater. 56 days after the sandbagging effort began, ELSR was breached and water began rushing into Eagle Lake. Backwater (BW) 97.81' and Eagle Lake (EL) 93.56', a 4.31' difference. We're worried that the speed and volume of the water will wash away our foundation. Day 1 of water under our house. 5/19- 6/19/20: By day four or five the Backwater and Eagle Lake were equalized at 98.16' and 98.15'. I left the lake in order to work, Jim working part time and stayed home to protect our property. Parked his truck behind the Brunswick levee and boated home. On 5/30/19 WLBT News does a story on the flooding and	See response to comment 1
105	7/21/2024	General Public	General Support	I support the Yazoo backwater pumping plan to help relieve backwater flooding in the lower Mississippi Delta. I am 72 years old and in 1973 as a member of the Mississippi National Guard I was called out to help people evacuate during the 1973 flood and I witnessed first hand the hardships the 1973 flood caused people, animals and the devation it caused crops, plant life and infrastructure. The area of Mississippi where I'm from the old people always talked about the flood years of 1913, 1927, 1937. It was hard for me to imagine the water levels they talked about as I looked out across dry dusty farm fields and for the most part dry woodland until I saw it for myself in 1973. After the 1973 flood I started researching for myself and soon found out the lower delta flooding problem had been recognized since the 1920's and studied by the US Corp of Engineers and a plan had been submitted as early as 1940. But nothing happened. There have been numerous floods since 1973 with the most notable 2011 and still nothing has happened except political tom foolery. The people living in the lower Mississippi delta deserved better than this. My support for backwater flooding relief is unwavering.	See response to comment 1
106	7/22/2024	General Public	Alternatives	This area never is featured in the study, why? Since the flooding the two access bridges have been removed in this area, why?	Comment noted. The proposed water management solution would provided flood risk reduction to lands, buildings, and infrastructure located at an elevation above 93' (at the Steele Bayou gauge).
107	7/22/2024	General Public	H+H	Goose Lake Road, home of Taylor family, their natural gas, Atmos lines were removed and not replaced. Ms. Taylor has not been able to return to her family home and no one cares.	Comment noted. USACE extends it's full sympathy to those affected by flooding in the project area. Through interagency collaboration, a range of feasible flood risk reduction measures have been developed to reduce risk to those residing and working in the study area.
108	7/22/2024	General Public	H+H	Every flooding year, these areas floods, where road access is cut off and home owners have to move.	A vast majority of Goose Lake Rd lies between the elevation of 93' and 98.2'. It is anticipated that the proposed water management solution would prevent inundation and isolation of homes along reaches above 93'. See response to comment 41.
109	7/22/2024	General Public	EJ	Why in this planning no one put actual foot soldiers to knock on doors of residents, where ever they maybe now to ask the questions, what they feel is needed.	Comment noted. However time and cost prohibit such a survey, public meetings are the normal way to engage with the community on issues they may regarding the proposed project and measures they feel should be investigated.
110	7/22/2024	General Public	EJ	Sadly, all these meetings, it has accomplished hidden agendas, I feel, A) To dismiss the low income and small farmers to the point of what I witness today, where very, very few of people of color are in attendence, although they have been the backbone of these generations after generations proud farmers and no one dare recognize or ask the question, where are they?	Comment noted. Additional EJ outreach mtgs have occured and more are planned to take place to hear from residents in vulnerable communities.
111	7/22/2024	General Public	EJ	B) Where in your plan includes those small farmers and owners to benefit from staying or coming back?	Comment noted. Long and short term trends, as well as potential benefits and impacts from the proposed project action can be found in Sections 4 and 5 of the EIS.
112	7/22/2024	General Public	General Support	I am not able to attend any of the meetings scheduled for this week but would like to provide these comments: The I remember before the Steele Bayou structure and the canal were built the south delta residents were told that after the structure was completed in 1969 a follow on project would install a pump system to remove flood waters above a certain level. Studies were still being conducted to determine the best elevation to limit the water level upstream of the structure. I attended the first meeting held in Rolling Fork. I don't recall the date of that meeting but it was about 55 years ago. From that time forward out of state so called "conservation" groups have been loud opponents. I graduated from MSUs College of Engineering in 1969. Several family members had careers with the Army Corps of Engineers at WES/ERDC. I retired from ERDC . In the past 55 years I have never talked with a local engineer or south delta farmer that did not support the pumps. They are the individuals that best understand the pros & cons of the pumps. Many have attended multiple meetings and voiced opinions supporting the pumps. I sincerely hope that the politicians who have to pass the funding bills will listen to our voices this time.	See response to comment 1
113	7/23/2024	General Public	General Support	My name is Rainer Roberts. I am from Yazoo county and I have lived next to the Yazoo River levee for 23 years. I come from a long line of farmers and every one of my closest friends works in agriculture. I have seen first hand how devastating the backwater floods can be to family's that I hold near to my heart. I have also seen what it does to the local wild life. The wildlife in my area are displaced greatly every time the water rises. It has pushed wild hogs into the hills and stranded deer on any dry land to the point of starvation. The Mississippi Delta needs these pumps.	Comment noted, see response to comment 1. However, disturbance events, such as flooding, may provide important ecological benefits and maintains the habitat which is capable of supporting wildlife.

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114	7/23/2024	General Public	General Support	OPTION #2. For farmers, families, wildlife!! Everything. #fixthepumps PLEASE!	See response to comments 1.
115	7/23/2024	General Public	General Support	> I am Nikki Woods, a lifelong resident of Holly Bluff, Mississippi. I live on Lake George, 2756 Satartia Road. My husband, Eric Woods of 17 years, and I have two children Lane,15 and Emmy,11. We love living in the country raising our children on family land beside my parents, Chuck and Gale Perry. My brother, Tre Perry also farms the land. I am here to say we desperately deserve and need the pumps. We need them ASAP. We need them to come on before it causes loss of roads used to travel back and forth to our jobs and schools, we need it for safety purposes also. As three people loss their lives in the flood waters. In 2019, March 3rd to be exact, I had to get together a few bags to move to Yazoo due to backwater flooding. I just thought we would be gone a couple weeks, but little did I know we would be gone for 19 months. It was some of the most depressing and mentally exhausting times of my 36 years. I watched my parents boat in and out to go get groceries and it took a huge toll on them mentally and physically. I saw them worried not only for themselves but for the lives of myself and my brother. All because we were trapped. Loss of use of homes, land, income. > In May of 2019, Eric and I decided to buy a camper to live in so my children could be near my parents because they keep them in the summer while we work. We moved it to our friends place in Holly Bluff from May to August 6th, 2019. We were finally able to move back to our own property. At this time, we struggled with mortgage company to get the insurance money to start rebuilding our home. On top of that, we needed to elevate our home as well. $48,000 was what we needed and after so much loss we didn't have this kind of money to come up with. Insurance programs offer $30,000 but after the the work is complete they reimburse you up to $30,000. Luckily, with the help of the bank we were able to start elevation in December 2019. > In January 2020, the river was back on the rise. My home literally was on a few wooden casings and the house mover feared it would not hold due to rising waters. So there again we had to pack up the camper and head back to Holly Bluff, leaving our home not knowing what was going to happen. > March 2020, COVID hit. Boy did this hit hard. Not only did this cause even more mental heartache. Supplies and shipping came to a quick halt. I can remember Easter vividly that year. A terrible storm hit. I remember feeling alone, scared, and helpless. I couldn't be with family due to exposure to Covid, as I am a nurse. I didn't want to expose my parents to this deadly disease but I so badly needed someone. > June 2020 the elevation of my home was complete. I ended up refinancing my home through a local bank and with their guidance on how to get my insurance money, we were able to start on our home. Finally, in October 2020 we were able to move back HOME! God was holding us up through all the storms! > With all that I have recounted above. I had no idea this all could have been lessened if we had pumps. Please move forward with the pumps ASAP! I know there are many stories out there that say the same. Listen to these stories and FINISH THE PUMPS. Thank you for your time.	See response to comment 1
116	7/23/2024	General Public	General Support	We own property on Eagle Lake Shore Road. We would love to build on this land for our children and Grandchildren to enjoy. We would use this as a second home for recreational purposes. It's hard to invest in something that is unknown. If we knew the pumps would be installed it would make this decision much easier. I also know that there are families that livelihood rests in the decision to finish the pumps. It's a shame that this has lingered for so long. My hope is that a decision will be made and work will begin sooner than later.	See response to comment 1
117	7/23/2024	General Public	General Support	Good evening I attended todays mid day meeting in Vicksburg. I listened to the comments from farmers and residents that dealt with the flooding in years past. I have grown up in Vicksburg and spent countless hours in the Eagle Lake and Mississippi Delta throughout my 40 years of life. It is sad to see what is still ongoing with this project or should I say lack of. I hunted along the Mississippi River just north of Eagle Lake for most of life, the flooding of the ms river in recent years has changed the landscape of the the delta. The bottomland that was once oaks, pecans, cottonwood, sycamores, ash, and persimmons is becoming predominantly a Willow thicket with what is left of the hardwoods decaying by the minute. I have managed hunting properties for the last 15 years in Ms, La, and Ark I see what goes on daily with wildlife and habitat in these areas. The amount of habitat that once flourished when I was a kid now looks very depressing to say the least. The invasive grasses and trees are beginning to take over the lower elevation areas that were once big beautiful pecan flats with occasional oaks(24-32 ft elevation areas along the river), the areas that were mid 30s to upper 30s have see deteriorating habitat as well along the river. The backwater side of the levee is detrimental for wildlife to survive, and during the high water events we have to find a way to keep it dry. I understand the concerns with wetlands but it's obvious the flooding is destroying hundreds of thousands of acres of forest and turning into wetlands due to flooding. Trees cannot withstand the prolonged flooding in the spring and summer. The dewberries that once thrived have become invasive sedge flats in areas, hardwoods have been replaced with wetlands habitat or ash flats. I know from managing 15k plus acres for the last fifteen years you cannot afford to fix the river now that it's where it is!! It's unbelievable the changes I have seen in my short time on this earth. This project is way overdue let's make a difference and put these pumps in. If you want to mitigate by taking some of the lower elevation areas and putting them into forest or Wrp I would support that but you still need a place for wildlife to go in the high water. I am no scientist, biologist, or engineer but I have lived in the woods for the majority of my life; I have seen the decline in habitat from these floods. These animals are just like people they wait until last minute to leave, but then come back as soon as water starts falling. It's vital we do everything we can to improve the habitat for wildlife on the protective side of the levee. The fishing has absolutely declined in these areas due to sediment and the changing landscape. There has been nothing good come out of the flooding! There are so many on going issues facing us today let's not let this one keep continuing to hold the people and towns of the south delta down. Businesses depend on the recreation, farming, and tourism in the south delta!! I support alternative 2 if I had to pick but I honestly think we can do better for the communities and the wildlife. Thanks for working on this project and I pray that something happens in the near future because future generations depend on it. I have a hands on understanding of this area, wildlife, and habitat would be glad to help anyway that I can.	See response to comment 1.
118	7/24/2024	General Public	General Support	I'm reaching out regarding the Yazoo Backwater Pumps. My family has lived in Yazoo City for a very long time - since the early 1900s. We have owned and operated a local business for 40+ years from my grandfather and now my father. The flooding that has occurred in years past has affected all people in the area including my family. If farmers in the area aren't making any money, then they aren't spending any money. If farmers aren't farming, then anyone associated with a farmer isn't making any money or spending any money. Restaurants, grocery stores, construction companies, the list goes on. I vote to support option 2.	See response to comment 1
119	7/24/2024	General Public	General Support	I live and farm on the northern fringe of the area that flooded in 2019. I filed a prevented planting crop insurance claim on 100 acres of my low lying land that year. It was the first such claim for me as a farmer. That expense to the crop insurance company and the loss of revenue to me because I was unable to produce a crop on that land could have been avoided had the flood control pumps been in place. Mine was just a tiny expense, though, compared with the losses on the farms, forrests, and the wildlife in the main flood area. The economics of installing pumps to avoid such losses is solid. I ask you to please focus your efforts on completing the pumps project.	See reponse to comment 1. However, economics to support justification of the pumps was not included in analysis or presented in the DEIS. Therefore, USACE presents no basis for economic comparison to comment on the anticipated project cost or potential economic gains to the project area. Rather anticipated flood risk reduction of comprehensive benefits, including protected homes, businesses, agricultural land, and infrastructure was used to determine the alternatives presented for consideration in the DEIS and from which one was ultimately recommended as the recommended plan in the FEIS.
120	7/24/2024	General Public	General Support	I attended several of the public meetings over the past several years regarding the Yazoo Backwater Pumps and I believe the residents of the area have covered every reason in the world as to why we need the pumps. And yes, those that don't live here and have never seen the reality of what can happen when a back water flood does occur, have stated their opinion as well and most of those should be considered irrelevant in my opinion. Bottom line - not having the pumps - a promised part of the flood control plan from the 1940s, and the only part never completed, is bad for the Economy, Businesses, Housing, Residents, Wildlife, Flora and Fauna of the South Delta. The 2019 flood decimated the economy of the South Delta. Agriculture is what drives this area, and when farmers can't farm, it trickles down and everything is affected. Businesses closed as a result of the flood. Homes were ruined as were roads Residents moved away Wildlife was killed and has still not rebounded to pre flood populations even today 5 years later - from black bear (a threatened species) to white tailed deer to squirrels to butterflies and other insects. - all of the food chain was affected. Invasive species and all manner of contaminants were spread all over the landscape through the flood, and much of this changed habitats forever. As far as wetlands go - The wetlands here have historically been seasonal wetlands, wet during the winter/spring season, and drying up summer, fall - for the most part. However, in 2019 the wetlands and other flooded areas were full from December through August in many places. While species and flora and trees may be accustomed to the seasonal floods, this extended wet season was not beneficial to them. Trees have died and are still dying today as a result of so much water over such a ong period of time - and hot water at that in June, July and August. I was in Delta National Forest in a boat in July of 2019 - it was eerily silent - no birds because there was no available food for them, and roads I've driven in the past were under 6+ feet of water. Since that time I've seen so many trees die and fall, a lot of weeds and growth where there once was none - due to movement from flood and loss of canopy. I participate in an annual NABA butterfly count each summer. We've still not had a count that reached preflood numbers, again loss of habitat and host plants. But trust me - the forest is still a seasonal wetland. Turning on the pumps WILL NOT destroy any wetlands - that's ridiculous. I am in favor of alternative #2 and please Finish the Pumps!	See response to comments 1, 90, 113, and 503.
121	7/22/2024	General Public	General Support	Areas of concern: Home accesibility, housing or property impact, access to emergency services, impacts to wildlife, impacts the wetland/enviroment, infrastructure (electrcity or road accesibility), agriculture (flooding of farmland or loss of livestock), and hunting or outdoor recreation.	See response to comments 1, 39, 45, and 90
122	7/22/2024	General Public	General Support	Areas of concern: Home accesibility, housing or property impact, access to emergency services, impacts to wildlife, impacts the wetland/enviroment, infrastructure (electrcity or road accesibility), agriculture (flooding of farmland or loss of livestock), and hunting or outdoor recreation.	See response to comments 1, 39, 45, and 90

Comment Number	Comment Date	Org.	Theme	Comment	Response
123	7/22/2024	General Public	e Management and Mc	Forestry damage 30 year for saw log awithout damage?	Comment noted
124	7/22/2024	General Public	General Support	Areas of concern: Housing or property impact, access to emergency services, impacts to wildlife, impacts the wetland/enviroment, agriculture (flooding of farmland or loss of livestock), and hunting or outdoor recreation.	See response to comments 1, 39, 45, and 90
125	7/22/2024	General Public	Wildlife	I feel as though this issue has been seen as farmers against the enviromentalist with the the enviromentalist with the enviromentalist champining the animals. The reality is that 2019 flooding was horrible and destructive for the wildlife and flora.	See response to comments 1, 39, 45, and 90
126	7/22/2024	General Public	General Support	Areas of concern: Home accesibility, housing or property impact, access to emergency services, impacts to wildlife, impacts the wetland/enviroment, infrastructure (electrcity or road accesibility), agriculture (flooding of farmland or loss of livestock), and hunting or outdoor recreation. Alternative 2 for march 16 is what the delta needs	See response to comments 1, 39, 45, and 90
127	7/22/2024	General Public	General Support	Areas of concern: Home accesibility, housing or property impact, access to emergency services, impacts to wildlife, impacts the wetland/enviroment, infrastructure (electrcity or road accesibility), agriculture (flooding of farmland or loss of livestock), and hunting or outdoor recreation.	See response to comments 1, 39, 45, and 90
128	7/22/2024	General Public	General Support	Areas of concern: Housing or property impact, impacts to wildlife, impacts the wetland/enviroment, infrastructure (electrcity or road accesibility), agriculture (flooding of farmland or loss of livestock), and hunting or outdoor recreation. Install the pumps and operate in accordance with oprion 2 ASAP	See response to comments 1, 39, 45, and 90
129	7/22/2024	General Public	General Support	Areas of concern: Home accesibility, access to emergency services, impacts to wildlife, infrastructure (electrcity or road accesibility), agriculture (flooding of farmland or loss of livestock), and hunting or outdoor recreation. Please support alternative 2	See response to comments 1, 39, 45, and 90
130	7/22/2024	General Public	General Support	Areas of concern: home accessibility, access of emergency service, impact to wildlife, infrastructure (electricity or road acceibility) agriuculture (flooding or farmland or loss of livestock)	See response to comments 1, 39, 45, and 90
131	7/22/2024	General Public	EJ	I have been employed for 50 years in health care in Sharky county. In 2019 our ambulances could not get to vicksburg to transport to river region hospital. Our ambulances could not get to homes to answer 911 calls. We had to take seet out CT macheince and store at for 3 months. we could not offer adquate medicaid swevices that year.	See response to comments 1, 39, 45, and 90
132	7/22/2024	General Public	General Support	Areas of concern: Home accesibility access to emergency services, impacts to wildlife, impacts the wetland/enviroment, infrastructure (electrcity or road accesibility), agriculture (flooding of farmland or loss of livestock), and hunting or outdoor recreation. I support alternative 2 we need this pumping station. built not only for the people but for the animals and enviroment as well. finish the pumps.	See response to comments 1, 39, 45, and 90
133	7/22/2024	General Public	General Support	Areas of concern: Agriculture (flooding of farmland or loss of livestock)	See response to comment 1.
134	7/22/2024	General Public	H&H	My fear is on March 16. Water is at 93 ft. the powers at be at the meeting said it took 6 to 7 days to pump a foot of elevation. If 3ft we are talking 18 dyas to90 ft which is after april 1st. We are at the end of corn planting season and ground still has to dry up. We need a lower starting point than 93 ft.	Comment noted, see response to comments 1 and 61
135	7/22/2024	General Public	General Support	Areas of concern: Home accesibility, housing or property impact, access to emergency services, impacts to wildlife, impacts the wetland/enviroment, infrastructure (electrcity or road accesibility), agriculture (flooding of farmland or loss of livestock), and hunting or outdoor recreation.	See response to comment 1.
136	7/22/2024	General Public	General Support	Levee at west bank of MS river acts as a dam or overflow waters normally goes west during a flood. water is not artifically impounded on the east bank of the MS river. Each water event is a seperate taking	Comment noted.
137	7/23/2024	General Public	General Support	Areas of concern: Home accesibility, housing or property impact, access to emergency services, impacts to wildlife, impacts the wetland/enviroment, infrastructure (electrcity or road accesibility), agriculture (flooding of farmland or loss of livestock), and hunting or outdoor recreation.	See response to comments 1, 39, 45, and 90
138	7/23/2024	General Public	General Support	Areas of concern: Access to emergency services, impacts to wildlife, agriculture (flooding of farmland or loss of livestock), hunting or outdoor recreation. Alternative 2 finish the pumps.	See response to comments 1, 39, 45, and 90
139	7/23/2024	General Public	General Support	Areas of concern: home accesibility, housing or property impacts, access to Emergency services, impacts to wildlife, infrastructure (electricity or road accesibility). Support alternative #2	See response to comments 1, 39, 45, and 90
140	7/23/2024	General Public	General Support	Areas of concern: Home accesibility, housing or property impact, access to emergency services, impacts to wildlife, impacts the wetland/enviroment, infrastructure (electrcity or road accesibility), agriculture (flooding of farmland or loss of livestock), and hunting or outdoor recreation. Proposal #2: please help us finish the pumps. we're tired and we need a sense of relief and safey. I am ready to move back into my home and finally line comforable and peaceful	See response to comments 1, 39, 45, and 90
141	1/7/1900	General Public	General Support	Areas of concern: home accessibility, housing or property impact, access to emergency services, impacts to wildlife, impacts to wetlands/environment, infrastructure (electricity or road accessibility) agriculture (flooding of farmland or loss of livestock), hunting or outdoor recreation. Given the choices alternative 2 is preferred. Please hurry, we have been drowning for 40 years!	See response to comments 1, 39, 45, and 90
142	7/22/2024	General Public	General Support	Areas of concern: home accessibility, housing or property impact, access to emergency services, impacts to wildlife, impacts to wetlands/environment, infrastructure (electricity or road accessibility) agriculture (flooding of farmland or loss of livestock), hunting or outdoor recreation. Finish the pumps	See response to comments 1, 39, 45, and 90
143	7/22/2024	General Public	General Support	Areas of concern: home accessibility, housing or property impact, access to emergency services, impacts to wildlife, impacts to wetlands/environment, infrastructure (electricity or road accessibility) agriculture (flooding of farmland or loss of livestock),	See response to comments 1, 39, 45, and 90
144	7/22/2024	General Public	General Support	Areas of concern: home accessibility, housing or property impact, access to emergency services, impacts to wildlife, impacts to wetlands/environment, infrastructure (electricity or road accessibility) agriculture (flooding of farmland or loss of livestock), hunting or outdoor recreation.	See response to comments 1, 39, 45, and 90
145	7/22/2024	General Public	Alternatives	Cropping season is wrong should start March 1 when crop insurance and I personally think elevation is to lish for wildlife and farming should be 87 to 90 instead of 90 and 93.	See response to comments 1, 39, 45, and 90
146	7/22/2024	General Public	General Support	Areas of concern: home accessibility, housing or property impact, access to emergency services, impacts to wildlife, impacts to wetlands/environment, infrastructure (electricity or road accessibility) agriculture (flooding of farmland or loss of livestock), hunting or outdoor recreation. We need the pumps to complete the original deal	See response to comments 1, 39, 45, and 90
147	7/22/2024	General Public	General Support	Areas of concern: home accessibility, housing or property impact, access to emergency services, impacts to wildlife, impacts to wetlands/environment, infrastructure (electricity or road accessibility) agriculture (flooding of farmland or loss of livestock), hunting or outdoor recreation. Build the pumps	See response to comments 1, 39, 45, and 90
148	7/22/2024	General Public	General Support	Areas of concern: home accessibility, housing or property impact, impacts to wildlife, agriculture, flooding of farmland or loss of livestock	See response to comments 1, 39, 45, and 90
149	7/22/2024	General Public	General Support	Areas of concern: housing or property impact, access to emergency services, impacts to wildlife, impacts the wetlands/environment, infrastructure (electricity or road accessibility), agriculture, flooding of farmland or loss of livestock, hunting or outdoor recreation	See response to comments 1, 39, 45, and 90
150	7/22/2024	General Public	Alternatives	option #2 please	See response to comment 1
151	7/22/2024	General Public	General Support	Areas of concern: impacts to wildlife, impacts to wetlands/environment, infrastructure (electricity or road accessibility) agriculture (flooding of farmland or loss of livestock), hunting or outdoor recreation.	See response to comments 1, 39, 45, and 90
152	7/22/2024	General Public	Alternatives	I am for the alternative that will provide an opportunity for economic growht that is not totally dependent on agriculture and the generational wealth that has dominate the delta.	See reseponse to comment 1
153	7/22/2024	General Public	Alternatives	We purchased our forever home in 2019 and 6 months later we had 4.5 feet of water inside our house. Please vote project #2	See response to comment 1.
154	7/22/2024	General Public	General Support	Areas of concern: housing or property impact, impacts to wildlife	See response to comments 1, 39, 45, and 90
155	7/22/2024	General Public	General Support	Areas of concern: home accessibility, housing or property impact, access to emergency services, impacts to wildlife, infrastructure (electricity or road accessibility), agriculture (flooding of farmland or loss of livestock)	See response to comments 1, 39, 45, and 90
156	7/22/2024	General Public	Economics	Economic impact grow year by year; widening the poverty gap between here and already impoverished MS. The only people left will be rich landowners and those too poor to move.	Comment noted, see response to comment 1.
157	7/22/2024	General Public	EJ	Loss of culture (former Native American, Blues/Delta &population	Comment noted, the proposed project is expected to help preserve culture of area by reducing flood risk to residents throughout the study area, most of which includes communties with EJ concerns.
158	7/22/2024	General Public	General Support	My home is affected by the backwater flooding on one side and relief flow well water on the other, as well as seepwater. I live within 100 yards from the ft. of the MS River levee) My familiy has been in that location for 140 yrs. We are at the extreme top of the backwater area but too many of our friends and family suffer from the flooding more often that we like to think about..	See response to comment 1.
159	7/23/2024	General Public	General Support	I see people are playing hardball about the pumps/no pumps issue and the Extravaganza. I am sorry to hear that. I do want to reiterate my feelings about the issue if it can help in any way. The "pumps/no pumps" is not a cut and dry issue. As a practicing waterfowl biologist in the south delta for over 10 years, I have had my share complications with the excess water that floods the south delta due to the drainage from the Yazoo Backwater Flood Control Project, the pumps would alleviate this problem. I do understand the big question of "how the pumps will be operated if put in." Sorry so long winded. I just wrote this this morning and did not check for accuracy as to publish or share. So please do not use this as researched facts Just my observations with a lot of holes in it. I would be happy to sit down with others to discuss this topic further and try to find a win-win solution given the present situation.	See response to comment 1

Comment Number	Comment Date	Org.	Theme	Comment	Response
160	7/23/2024	General Public	Wetlands	Basically wetlands can be negatively affected by not enough water and too much water. I was constantly battling too much water in the south delta. The wetlands here are also affected negatively by the excess water at the wrong time of year. When I was hired on Delta National Forest in 1990, we discussed the composition change and species richness reduction of the forests due to flooding. New to the area, I assumed flooding meant "flooding of the Greentree Reservoirs" for wintering duck habitat and hunting opportunities. We decided to rotate the flooding and flood every 3 years. After the winter season everything looked fine. 1/3 of the greentrees were flooded and 2/3s not. However, in March when I began to drain those that were flooded to imitate the natural drawdown, I ran into a real eye-opener, I was unable to remove the water for the growing season, because of the Little Sunflower River rising. By the End of March all the greentree levees were topped and I realized my error. The flooding was not due to my pumping the greentrees, but from the pooling of water in the south delta up against the gates. I recently asked a Forest Service employee, why they did not share this information during public hearings about the pumps The reply was they do not get involved in Political Issues.	See response to comment 1.
161	7/23/2024	General Public	Wetlands	While working for James River, I managed the native stands of hardwoods as well as the wetlands for wildlife. During a year when the Mississippi River does not get too high and goes downs fairly early in spring, I could see how the seasonal wetlands progressed throughout the year. The water drained off ridges or outer ring of the wetland early in March leaving most of the oaks and other hard mast trees on dry ground. As April progressed, the next ring of the wetland became dry and the species tolerant to water during this time began to sprout and flourish. Then the shelf dominated by willows and cottonwood began to dry out throughout May; hence the "snowfall" of seeds early and late May. At this time the native ground cover plants get established and flourish in the muddy areas beneath these trees, In June the cypress/buttonbush areas begin to dry allowing for reestablishment of these species if necessary. Finally, in July the center of the wetland becomes a mudflat and the moist season vegetation can get established (grasses, sedges, millets and rushes). And then the wetland species take advantages of the sparse seasonal rains that fall in late summer and early fall. Basically the wetland is dry, but an abundant of seeds are produced and dropped. When the winter rains begin to fall, the seeds become available for wintering waterfowl. The dying vegetation a food source for invertebrates in the late winter and the cycle begins again. This scenario is not for all wetlands in the south delta, there are some that should dry faster and some that remain wet year round. Recently there has been more and more excess yearly flooding and this year the wetlands I am speaking about are under about 15 feet of water and it is July. Historically, deviations occurred both flooding and drought, and these wetlands and associated habitat and wildlife survived. But recently due to the drainage project MINUS the pumps, excess flooding of these wetland has become the norm. The species cannot evolve fast enough to this man made flooding. The wetlands cannot function properly.	See response to comments 1, 45, 67, 90, 91, 113, and 503
162	7/23/2024	General Public	Wetlands	These wetlands I speak of are not farmland, but in forests like Delta National Forest, and other areas still wooded. These wetlands will not be harmed by the pumps but helped, with the caveat that the pumps are managed properly. And that is a big question mark, but without the pumps we know wetlands are being damaged, so let's work on making sure that the pumps are managed properly and we all can win. Perhaps we can use the pumps as leverage to have the wetlands of the north delta managed better???	See response to comments 1, 45, 67, 90, 91, 113, and 503
163	7/23/2024	General Public	Wetlands	I am a retired Waterfowl Biologist. I spent the last 25 years of my career working in the South Delta area of Mississippi. As you know this area is actually in the northwest corner of Mississippi; not the present delta of the Mississippi River. However, it is made up of a lot of alluvial soils because of the history of the river and its tributaries in this area. I want to tell you about my first experience in the South Delta. I graduated with my Masters in Waterfowl Management from Mississippi State University in 1990 with a thesis on the Wood Duck program at Yazoo National Refuge in the Delta. I was hired that fall by the United States Forest Service to work as a biologist on Delta National Forest which is in the heart of the South Delta. My first and foremost responsibility was to get the Green-Tree Reservoirs, part of the Yazoo Back Water Flood Control Project mitigation, ready to be pumped for wintering waterfowl. No problem! I worked with irrigation pumps, water control structures and flooding before-I got this! Several weeks later, at a meeting with the entire Delta Staff, the field forester Ralph, mentioned to me that there was a species composition change and reduced diversity in the Forest due to the flooding, and said "check out your green-tree reservoirs". This was 1990. You have to understand Ralph; he gives you enough information for a valuable lesson or enough for you to hang yourself (I didn't know this at the time). I thought trees, especially ones here, should be able to handle winter flooding (by the way I grew up in Pennsylvania and moved to Mississippi to go to MSU from Montana/North Dakota); but, I had heard that Ralph was super smart and had been working on the Forest for a long time and knew his stuff. So I decided with about 9 GTR compartments we could flood 1/3 of them a year and that would give the forests a relief the other 2 years; hopefully providing wintering waterfowl with enough flooded water - I got this! So choosing which GTRs to flood, I was on my way, easy-peasy! The fall and winter went well: Pumps worked, had enough water in the Sunflower River with the fall/winter rains, birds used the flooded areas, and visitors (hunters and bird watchers) to the forest were happy. Success!!! Now, all I had to do was drain them appropriately and continue on with other projects. So, in March, I began to pull the boards that were holding water in the GTRs. I started pulling them one board at a time allowing for the water to lower slowly so invertebrates and other organisms could adjust to the lowering levels. In about a week, the Sunflower River started to rise. Maybe just a bit due to local rains, I thought. I continued pulling boards. Then the river was at the same level as my GTRs, then higher; so, I started putting boards back in. Oh yes, I had to put boards in the GTRs that were never flooded. The river kept coming up and overtopped the GTR boards and the actually levees, so now all GTRs were flooded even the ones I purposely didn't flood to help the trees. So I learned a valuable lesson, it wasn't the flooding of GTRs hurting the forests on Delta National Forest, but the rising of the Sunflower Rivers - ergo the back water flooding due to the lack of the Pumps. So you can see, the back water flooding was degrading the forest on Delta National Forest before 1990. When I asked an employee recently why they have not been more vocal on this issue, they said they cannot comment on Political Issues. I hate that this has become a political issue. Professional working for State and Federal Agencies in the South Delta have their hands tied.	See response to comment 1.
164	7/23/2024	General Public	General Support	Please consider my letter, as a retired Wildlife Professional, support for the construction of the Yazoo Backwater Flood Control Pumps.	Comment noted, see response to comment 1

Comment Number	Comment Date	Org.	Theme	Comment	Response
165	7/23/2024	General Public	Wetlands	To whom it may concern: I am a retired Waterfowl Biologist. I spent the last 25 years of my career working in the Mississippi South Delta. I would like to discuss the annual cycle of the majority of wetlands which evolved as seasonal wetlands here. Many people think a wetland is a wetland! And I have noticed this is the theme to the negative comments about this project "destroying 1000s of acres of wetlands." This is just NOT TRUE. The acres of flooding will be reduced by 1000s of acres, but these acres are not wetlands; they are roads, houses, uplands, farm fields, etc. Most of the wetlands here in the South Delta are not permanent, but seasonal wetlands. Historically they fill during winter rains, and are dry by July. The periodic spring flooding of the Mississippi River in past centuries did not have a significant impact on the evolution of these wetlands. If the River did overtop is banks, the flood waters rose over the already full wetlands and the ridges for several days in early spring than drained out. I want to summarize what the seasonal or monthly changes to these wetlands should be, without the prolong manmade flooding of recent decades; and how vegetation and waterfowl adapted to this natural rhythm. This is a simplification, but I want to describe the seasonal progression of a wetland I managed focusing on ducks. The wetland is like a soup bowl; it has a slope from the edge or ridge, this slope goes down to a step or flat (where the parsley or other herb is sprinkled in a fancy soup bowl), then there is another slope to the bottom of the wetland or bowl (where the soup is). The difference between the wetland and the soup bowl is that the wetland has ridges in the bottom, most less than a foot high, but significant none the less (plus it is not round, but elongated because it is an old oxbow). So let me list the changes that should occur to the water and vegetation in my wetland as the year progresses. Starting in early spring: this seasonal wetland is full from the winter rains. If the river floods, it leaves quickly allowing the upland vegetation on the ridges around the soup bowl to begin to sprout, germinate, and leaf-out in February and early March. The ridges have an overstory of red oaks, elms, sweetgum, pecan, and hickories; maples, mulberry, pawpaw and winged elm are in the understory. Ground cover species bloom quickly before the overstory steals all the sunlight; cane, vines and briers patches abound. My wetland is still full of water. March comes and goes, water in the wetland soak into the ground and begins to evaporate due to the warmer, sunny weather. The upper slope of the soup bowl begin to emerge as the water goes down. There is a new flush of green; a different type of trees, shrubs and herbaceous vegetation grow on this upper slope due to when the soil emerging from the water. Ridge species begin to fade out and later flushing nuttall, water and willow oaks, hackberry and persimmon are in this area and begin to green up. During April again evaporation and infiltration lowers the water in my wetland. The bottom of the upper slope is now greening up; and another ring of desirable vegetation will flourish. In May we have "snow storms" of willow and cottonwood seed floating on the winds trying to find a place to land and germinate. With the water levels dropping and the step becoming a mudflat, it is perfect timing for these trees to get started! If there are already cottonwood and willows established, the ground vegetation of smartweed and other wetland species flush out. Willow tree leaves are thin and drooping and cottonwood leaf petioles are flattened so the leaves hang down also, allowing for sunlight to reach the forest floor. As June progresses, the lower slopes of my wetland are now drying out. On this slope and on the ridges in the bottoms cypress grow. Buttonbush thickets form at the base of the cypress and on the ridges in the bottom of the wetland. These species can tolerate a lot of water, but not if it overtops the tips of the plants and stay too long into to July when the water will be so hot that it actually scalds the young trees and shrubs. Sedges and rushes also take hold in these areas when the water leaves at the right time. And then July comes; and it is hot and dry. The bottom of the slough is now a mud flat; grasses, millets and other warm season vegetation begin to grow. They have to grow fast, the bottom dries so quickly that they don't have much time before the moisture is gone. Woody vegetation doesn't grow in the bottoms normally, the season and moisture dictate what grows here. By the end of July, the plants we call warm season grasses or moist soil plants have mature and will produce a layer of seeds sometimes inches thick in these bottoms. This seed bank is so important for the wildlife especially waterfowl and it NEEDS to be here in the bottom. Now it is August, the bottom of the slough begins to crack the moisture goes deeper and deeper into the ground. Cracks as wide as 6 inches and several feet deep are present throughout the bottom of my wetland. Nothing is growing, but the feast is laid in preparation for winter. September bring early fall rains. The cracks begin to close as the moisture gets closer and closer to the surface of the slough bottom. All other levels of the slough; bottom ridges, lower slope, the step and upper slope and ridges have vegetation maturing and getting ready for winter. Blue-wing teal pass through but this seasonal wetland is not ready for them, there is no pooling water. October/November brings other migrating waterfowl (mallards, wigeons, gadwalls and more) to the Delta. And water is beginning to pool in the bottom of my wetland. All those seeds are there for them to feast on and recuperate from their migration. December and more rain. Now the water in the slough bottom is too deep for dabbling ducks to get the seed; but that's ok in a normal year they probably already ate most of it and now the water depth on the ridges and lower slope is just right for them to get button bush and other seeds dropped there. January rains raise the water into the willow/cottonwood flats. In normal years the ground vegetation there is very leafy and it and the willow and cottonwood leaves and branches are perfect for aquatic insects to live. Waterfowl at this time are preparing for molt, migration, and egg production. The birds need these insect larvae for the required nutrients. Ducks are also beginning to make pair bonds, the water around the buttonbush branches and the willow and cottonwood trunks are necessary for seclusion. Its February again, water is now near the top of my slough, ducks are utilizing seeds and acorns in this area as they migrate out to their summer nesting grounds. The cycle ends and a new one can begin. But what happens to my slough when flooding occurs like it did in 2019 and 2020. Water remained high in the slough, actually over the slough and the surrounding ridges. Vegetation did not flush when is should have because the water did not retreat it a timel fashion. Cottonwood and willow seeds never landed on mudflats, so they didn't germinate and were not available for wildlife to eat and nest in. briers did not grow, cane was under water and did not sprout, no vegetation grew in the bottom of the slough. Most animals died or at least were not able to nest and/or reproduce. When the slough did start to dry out in late July, no vegetation grew under the willow/cottonwoods it was too late in the season. Some vegetation like cock-a-bur did grow in August, but it is not a desirable or sustainable species for wintering waterfowl. As winter comes the birds will come, but there will be no food in my slough and they will leave. They will have to compete with other waterfowl in areas they are not familiar with and they might not survive. This excessive flooding is not something the vegetation and wildlife in the South delta can withstand yearly. Please realize this paragraph describes not only my wetland during 2019 and 2020. It is the scenario of all seasonal wetlands in the backwater flood area of the Mississippi Delta when we have water like we did in 2019 and 2020. When I talk to others that have lived here in the South Delta longer than I have, I notice that these severe flooding events are happening more often and for a longer period of time. This, I am sure, can be attributed to more and more modifications of the Mississippi River watershed up river and to climate conditions changing causing more local rains in and around the Yazoo Backwater Area. These conditions are not going to go away. The wildlife and wetlands in this area need the pumps as much or more so than the residents and farmers	See response to comments 45, 67, 90, 113, and 503
166	7/23/2024	General Public	General Support	The pumps will be a win, win, situation for people and the natural resources in the South Delta. Please, build and utilize the pumps!	See response to comments 1, 45, 67, 90, 91, 113, and 503
167	7/23/2024	General Public	Wildlife	Turkeys starved in treetops. Ravenous raccoons killed nesting turtles and newborn fawns. Countless other wild animals perished during a record 219- day flood last year in Mississippi's Yazoo Backwater Project. The Yazoo Backwater's surrounding levees provided the only high ground for displaced wildlife, but all those miles of manmade barriers provided little sanctuary throughout the unprecedented deluge. The Backwater, or South Delta, covers about 1,550 square miles of fertile valley in west-central Mississippi north of Vicksburg, where the Yazoo River flows into the Mississippi River. The Yazoo Backwater reached flood stage (87 feet) on Jan. 4, 2019, peaked at a record 98.2 feet on May 23, and stayed above flood stage until Aug. 10. The flood's crest coincided with the region's peak nesting and fawning periods, crushing populations of wild turkeys, whitetail deer, and ground- nesting birds.	See response to comments 45, 67, 90, and 113
168	7/23/2024	General Public	EJ	The Backwater's floods also drowned two people, covered three highways, and swamped or destroyed 686 residences. The seven-month flood caused at least $800 million in agricultural losses and damage across half a million acres of farm fields. When the stagnant waters finally receded in late summer, residents and business owners returned to homes and buildings fouled by sewage, garbage, agricultural chemicals, snakes, and rotting animal carcasses. Unfortunately, sustained rain and prolonged flooding returned this year, furthering the losses of homes, property, croplands, and wildlife.	Comment noted. See response to comment 1.

Comment Number	Comment Date	Org.	Theme	Comment	Response
169	7/23/2024	General Public	Wildlife	William McKinley, deer program coordinator for the Mississippi Department of Wildlife, Fisheries, and Parks, said the Backwater's 2019 fawn "crop" was devastated. So was the entire turkey population. Agency biologists and researchers at nearby Mississippi State University documented only four turkeys in 8,790 wildlife photos taken in October 2019 during a month long post-flood study using 300 trail-cameras. That study on the Shipland Wildlife Management Area, one of seven WMAs that flooded, also estimated a 5% fawn survival rate. The biologists conducted weekly deer surveys along a 26-mile route on the Backwater's southwestern levees. They regularly photographed emaciated deer and counted 503 dead whitetails from mid-June to early August. They necropsied deer when possible, and attributed most deaths to starvation and heat exposure. And because this is where Mississippi first detected chronic wasting disease in February 2018, they also collected tissue samples for CWD tests. Much of the devastation occurred on levees flanking the Yazoo Backwater's western border with the Mississippi River and its eastern border with the Yazoo River. If this were an animal horror movie, warning signs on the levees would read, "Abandon hope all ye who enter here." Everything that could fly, walk, crawl, or slither sought refuge on the containment walls. Once there, they fought for food, shelter, and shade-all of which were scarce. McKinley said starving raccoons proved a nuisance and nemesis to all. They honeycombed the levees by digging burrows for shelter, making it difficult for agency and university biologists to walk without stepping into holes. "I figured the raccoons would live up in the trees, but they settled into holes all across the levees and stayed," McKinley said. "You had to be careful where you stepped. Every 25 yards you'd find a hole with a raccoon in it. We have no idea how many were out there, but they were dying, too. They were in poor condition; unkempt and unaware, and in really poor health. When they were scavenging something, we'd get within 4 to 5 feet before they realized we were there." Turtle Carnage When the biologists weren't dodging raccoons and their burrows, they were driving or stepping around their means to survival. "Empty turtle shells from red-eared sliders were everywhere," McKinley said. "There were thousands of them. One time we saw three raccoons tussling over a big red-eared slider. All the female turtles were on the levees. They had nowhere else to lay their eggs. The raccoons figured them out quickly. They chewed off a rear leg, reached up inside for the eggs, cleaned everything out, and moved on to the next one. They picked them clean. Those turtle shells looked like they'd been steam-washed." McKinley thinks raccoons also killed newborn fawns soon after birth. Every pocket of shade held animals, so pregnant does couldn't seclude themselves when fawning. "I can't document it, but it looked like the raccoons just gathered around the does and waited for fawns to drop," McKinley said. "I firmly believe that. The only broken bones were the fawns' ribs, so I doubt something bigger killed them and that the raccoons just cleaned things up. All the bigger bones were chewed, not broken. All the meat was picked clean." McKinley said those scenes were among the flood's many unexpected sights and behaviors. During most floods elsewhere, deer flee lowlands for the nearest hills and higher ground. Some deer from the Yazoo Backwater probably did, too, but many did not. Those remaining spent so much time in water that their hooves grew soft with rot. McKinley also recalled counting 1,200 deer scouring a field in 12 inches of standing water on a hot day, three hours before dark. "We can't explain why so many deer stayed," McKinley said. "They have ways to get out, but it's not easy. On the other hand, assuming some deer fled, if they had CWD they carried it to new areas. We have lots of questions that will take a while to answer." McKinley said most songbirds also fled the Backwater, but there was no escaping the stench of death and unique, unexplained oddities. Paper wasps, for instance, usually build their papier-mache nests just off the ground in low brush. But with floodwaters covering brush and reaching far up trees and powerline poles, the wasps built their volleyball-size nests on the powerline's thick wires. "We'd be driving along and see a wasp nest on a wire, and wonder why would they build there with trees everywhere," McKinley mused. "But then we'd see another nest, and another and another up on the wires."	See response to comments 45, 67, 90, and 113
170	7/23/2024	General Public	Wildlife	Turkey Struggles The Yazoo Backwater's wild turkeys, however, left scant evidence of their presence or passing. Adam Butler, wild turkey program coordinator for the Mississippi DWFP, said the area's turkey flocks had already declined much of the past decade because of frequent flooding, but brood surveys in 2018 suggested a considerable boost for the population. Unfortunately, last year's flood made poult production impossible, and Butler worries the flock lost the previous year's gains, and maybe more. He said turkeys can't live and forage for long in treetops, and can't find food closer to the ground during floods. That's not just Butler's opinion. He references research by Michael Chamberlain, a recent guest on the MeatEater Podcast (Episode 214), who documented only one in five adult turkeys he monitored in 2011 survived a month-plus flood farther south in the Atchafalaya Basin. Chamberlain noted that turkeys move to higher ground if they know it exists. But if that ground isn't high enough to escape floodwaters, turkeys just keep searching their known turf until starving to death. At least that's what Chamberlain's GPS-collared turkeys showed. Here's how that went: A bobcat killed one hen the day the flood began. Another hen lived 21 days, and a third disappeared. It's unknown if the missing hen's collar malfunctioned or got destroyed in the flood. The lone surviving hen found dry ground 29 days into the flood as waters receded. The lone tom should have stuck with her. It died in a water-inundated area 31 days into the flood. "Turkeys aren't like deer," Butler said. "Turkeys typically stay near home. They don't know the land beyond the horizon." Butler said the Yazoo Backwater's turkey flock typically isn't large, and usually cycles with regional flooding. The hatch booms to bolster the flock in years with short flood seasons, and busts in years with heavy flooding. Adults typically endure because most floods recede after two to three weeks. Insects and vegetation pop up soon after, and life goes on. Watery Trend That pattern fell apart the past decade because of prolonged rains and flooding. "Adult turkeys can't survive in the trees' canopy six to seven months like we saw last year," Butler said. "We expect their survival in the Backwater last year was very low. It's possible the survivors might pull off a hatch this year, but it's getting late [April 29] and the river is still at flood stage."	See response to comments 45, 67, 90, and 113
171	7/23/2024	General Public	h&h	The 2019 flood and its harm to people, property and wildlife aggravates a long festering debate in the Yazoo Backwater and extended Mississippi Delta system, which spans 200 miles from Vicksburg to Memphis, Tennessee. Levees on the valley's entire western edge protect it from the Mississippi River's floodwaters, and levees on its southeastern side protect it from the Yazoo River's floods. The land mass in between covers nearly 4,100 square miles, slightly smaller than Connecticut. And here's the scary part: All water and waterways within the leveed valley have only one way out: a "bathtub stopper" called the Steele Bayou Structure upstream from the Mississippi River. When the Mississippi floods, the Army Corps of Engineers shuts the Steele Bayou control gates to prevent floodwaters from backfilling the Yazoo Backwater and larger Delta. That's no small task. By the time the Mississippi River reaches Vicksburg, it's carrying 41% of the continent's runoff, which includes its own watershed starting in Minnesota; the Missouri River's watershed starting in Montana; and the Ohio River's watershed starting in Pennsylvania. When a swollen Mississippi River forces Steele Bayou's floodgates to shut, residents pray that winter and spring rains stay away. If they don't, the Yazoo Backwater starts filling. Everything will be fine if the Mississippi River recedes before the Backwater reaches flood stage. If not, the 2019 scenario unfolds. (That buildup began in October 2018 with sustained heavy rains.) The Backwater's original engineers considered such emergencies: They would build a giant pumping station at Steele Bayou once the structure was finished (1969). To prevent disasters like 2019, those pumps would evacuate rainfall trapped within the levees. But the pumping station was never built. Funding squabbles between state and federal officials delayed construction for decades, and then the Environmental Protection Agency ruled against the pumps in 2008. Regional rainfalls since then have caused simultaneous flooding inside and outside the Backwater several times.	See response to comment 1

Comment Number	Comment Date	Org.	Theme	Comment	Response
172	7/23/2024	General Public	Wildlife	Meanwhile, hunting clubs, conservation organizations, and the Mississippi DWFP spent much of the 1980s and 1990s using the Conservation Reserve Program and Wetland Reserve Program to help improve the Delta area's turkey habitat. Butler hopes all that money and foresight wasn't in vain. "A lot of those trees are now 25 years old, and turkeys can probably start using those areas over the next five years," he said. "We'd like to get back to doing some trap-and-release to help re-establish those flocks. It would make a great turkey woods if we give it the needed time. That would be a real success story."	See response to comments 45, 67, 90, and 113
173	7/23/2024	General Public	General Support	I know the COE has been working in the South Delta for years and are asked again and again to do another study. I feel this request is just a way to postpone the completion of the Yazoo Backwater Project (Pumps) project. Or it is a fishing expedition from those against the pumps hoping to find evidence that the pumps are harmful. It is my understanding all the studies to date have not found that the Pumps will be harmful to the environment in this area. I just want to emphasize the organizations and professionals that like you work in this area that are supportive of the pumps and some organizations that are supporting the pumps from afar. Mississippi Department of Wildlife Fisheries and Parks voted in June 2019 to support the pumps because of the negative impacts on wildlife populations. Nature Conservancy in Mississippi letter of August 2019 noting flooding imposes a tremendous burden on the natural resources. Mississippi Forestry Commission pass a resolution in support of the Pumps March 10,2020 "adverse impacts on natural habitat, wildlife, and trees." The Mississippi Wildlife Federation changed their position from against the pumps in their letter of intent to sue earlier this year.	See response to comments 45, 67, 90, 113 and 503
174	7/23/2024	General Public	wildlife	Although I haven't found any documentation from the USFS against the pumps talking to past employees they have talked about the devastation that is being done on Delta National Forest. I personally worked on the DNF as a biologist in 1990 and was told by a forester that "the flooding was causing species composition change and reduction of species diversity". As the waterfowl specialist there I saw the negative impacts while trying to manage for wintering waterfowl. Employees of the local USFWS have mentioned big trees falling due to the soil being waterlogged in the summer.) this is evident in most wooded areas in the South Delta after the 2020 flooding. As a biologist for a timber company and working in the South Delta I can attest to the damage to the trees and wildlife in the area.	See response to comments 45, 67, 90, 113, and 503
175	7/23/2024	General Public	General Support	The Audubon Society as far as I know has not changed their position against the pumps, but their article against the pumps is not as prominently displayed. I had read several comments about the areas from retired professionals in the South Delta showing that the article has several inaccurate statements in it. I wonder when they say the pumps will drain 200,000 acres of wetlands and other sources are saying 200,000 acres of farmland are flooded. Are they the same acres? If the 200,000 acres of farmland is flooded, then the acres of actual wetlands are flooded also. And too much water in a wetland during the summer month is as more detrimental than not enough. I also just realized that Audubon Society does not have an office in Vicksburg anymore. I have talked to foresters, biologists, conservation officers, land managers that have worked or are still working in the South Delta Area. We are all in agreement the pumps will help wildlife and habitat. Please do your best to convince the EPA that the Pumps will be alleviating man made flooding and will help the communities and wildlife in the Delta.	See response to comments 1, 45, 67, 90, 113, and 503
176	7/23/2024	General Public	EJ	Points I would like to make to rebut some other statements. 1."The pumps will not ONLY help the rich white farmers." a.The farmers (rich white, poor white, rich black, poor black) have insurance so when there are flood years like 2019 and 2020; it breaks their heart more than their bank. b.It is the community and residents that depend on the farmers that loose most of all. i.The restaurants that depend on the farmers feeding their planting and harvest crews will not have business if there is no planting or harvesting. ii.The seed, chemical, fertilizer, equipment, parts stores, those businesses that are in the south delta because of agriculture, will have no business if there is no farming for the year. iii.The laborers whether farm or other business will not be able to work if there is no agriculture for the year. iv.Other private businesses like independent truckers, electricians, lumber companies, daycares, barbers, you name it are in business because of the agriculture holds residents in the area and these businesses can survive. So, in actuality, everyone else will benefit more from the pumps than rich white farmer	Comment noted. See response to comment 1.
177	7/23/2024	General Public	Wetlands	2."Building the pumps will NOT destroy 300,000 acres of wetlands in the South Delta." Like mentioned in one article. a.There are only 290,000 acres of wetlands in the south delta - do I need to say more about that statement? Creative Marketing, maybe???? b.The project is all but completed; the infrastructure - ditching, levees, gates, weirs, etc, is done. The only thing left to do is putting in the actual pumping station in, and this final proposal is to put the pumps where they were originally planned, and it is my understand that the pad dirt work is already completed. So, point blank, this information is not truthful. Unfortunately, the organization making this statement and other organizations against the pump stating the pump will be detrimental to wildlife and wetlands do not have active programs or people on site in the South Delta. Enough said!	See response to comments 1, 45, 67, 90, 113, and 503
178	7/23/2024	General Public	General Support	1.As biologist, forest manager and conservationist working and living in the South Delta over the past 30 years, I am for the completion of the Yazoo Backwater Pumps Project by taking the final step and installing the pumps. I was excited to see the addition of wells placed in the north delta to maintain the aquatic streams and bayous that tend to dry up in the summer. Living and working here in the South Delta has open my eyes to the uniqueness of the area and how the uncompleted Yazoo Back Water Pumps Project has affected it.	See response to comment 1
179	7/23/2024	General Public	H&H	a.First let me describe some the wetlands in the South Delta; a significant number of wetlands are seasonal. They are like soup bowls spread out on a table. Between the soup bowls are the "ridges" there are also ridges along the creeks, rivers, and bayous; with one side usually, a high ridge while the other side is sloping due to river movement. Then also between significant creeks and rivers there are flat ridges where the farmland is now located as well as the towns. This is where the "Mound Builders" also had their communities and farmlands. And it hard to believe but there were a lot more people in these historical cultures living in the Delta than people live there now. The rainy season in the Delta is in the winter early spring. These rains fill up these seasonal wetlands, Not the Mississippi River! Similarly, to the seasonal wetlands, the shallow and deep aquafers are not replenished by the River. b.The River built and shaped the Delta over millions of years. River flooding to the height of the 1927 and 2011 floods are labeled the 500-year flood. These levels have a 1/SOOth chance of happening each year. So, statistic says they can happen back to back or never. Some people think of these happening every 500 years. Then there are the 100 year floods and the 50 year floods that happen more frequently. BUT to have 2 500, 12 100 and over 20 SO-year floods in a 100-year period didn't happen historically. So why now? MAN. It is not just happening in the Mississippi Delta or the areas that have similar back water projects on both sides of the river, but up stream. Think about how many thousands of acres of the Mississippi Watershed is paved over, has houses on, is ditched and has vegetation modifications. All this sends more water down the River to the gulf. With projects like this all we can do is try to mimic nature as best as we can to maintain the vegetation and wildlife that adapted to the historical conditions. The changes we made to the area in the last 200 years are happening to fast for the plants and animals to adapt.	See response to comments 45, 67, 90, 113, and 503

Comment Number	Comment Date	Org.	Theme	Comment	Response
180	7/23/2024	General Public	Wetlands	c.So, what is the pooling of the yazoo backwater flood water doing to the wetlands and wildlife. Remember the over-the-bank flooding of the Mississippi River historically was due to snow melt from up stream. This happened in Feb/March. The river came up flooded out at different levels depending on the year into the floodplain and then receded quickly depending on the height 10 to 20 days. The river depth and width were able to contain other runoff throughout the rest of the year. No levees holding and gates and ditching holding and directing the water. The plants and animals adapted and flourished in these historical conditions. The trees even the cypress are deciduous; an adaptation to the winter storms when standing in water (less likely to windthrow with out leaves). They were dormant during the winter allowing the standing water in the winter to not affect their growth and health. The water left from the tree roots prior to leaf out. Thus, allowing for growth and root health. Some trees adapted (like willow and cottonwood) to leafing and seeding out later and are able to be at lower elevations in the wetlands with out being stresses. Cypress and Tupelo Gum are even later and have extra adaptations to deal with standing water later in the spring.	See response to comments 45, 67, 90, 113, and 503
181	7/23/2024	General Public	General Support	Hi, Jackie Kerr retired waterfowl, biologist. I was told I couldn't talk as long today as I did last time I was here, so I thought I better write down what I want to say. And that is just thank you. You were asked to find a solution to this problem with a new set of eyes and ears -that's like a judge telling the jury to disregard that last statement. Is that possible? Obviously so because you did it. You disregarded what was said on either side for the past 20 years, you disregarded politics, you looked at what was being said not who said it nor how many times something was repeated, you looked at the research, not the conclusions others drew from it. You used your compassion, knowledge and experience and came up with a plausible solution for everything and everyone. We are indebted to you and I hate to ask you for more: but I'm am. When you get back to the hill, please do everything in your power to get this project with no strings attached initiated right away, the construction started and completed as soon as possible. I for one am looking forward to seeing the south Delta, Delta National Forest, and other wetlands habitats on the right path back to being what they should be. And if there's anything we can do to expedite this, please let us know. Again, Thank you, THANK YOU, Thank you.	See response to comments 1, 45, 67, 90, 113, and 503
182	7/23/2024	General Public	Wetlands	Hi, Jackie Kerr. First, I want to say thank you for your time and effort you put into this extremely important issue to the South Delta. Please count me as one who supports the Yazoo Backwater Pumps Option #2. I worked as a Waterfowl Biologist and Forest Manager in the South Delta for nearly 20 years. I want to speak for the wetland ecosystems in this area. The wetlands need a pump and option# 2 will serve them best. As a biologist it didn't take but 3 months on Delta National Forest to become painfully aware of the issues with the Backwater flooding when I started working in 1990. It is very hard to manage wildlife habitat when it is flooded during the growing season. Even though this area was always influenced by water; first as a delta and then as a floodplain, THIS FLOODING IS DIFFERENT, IT IS MANMADE. The soil, flora and fauna evolved with winter flooding; not high water during the growing season. This MAN-MADE FLOODING during the summer is causing specie shift and diversity reduction and lack of plant growth and seed production so important for the bottomland hardwood ecosystems and especially wintering waterfowl. I participated in a butterfly count on the forest last week. It was easy to see forest is being degraded due to this flooding. Someone new to the area could say what a beautiful forest and I would say you should have seen it in the 1990, But when I was there in the 90s, people said you should have seen it in the 40s and S0s. The effect of the 2019 and 2020 back to back summer flooding is obvious. There are so many dead standing and fallen trees. This is not the way a bottomland hardwood forest should look. It is not a healthy ecosystem. Scientists have documented this decline. look at pond berry colonies. Way down from 1990 to 2022. To halt and reverse this decline we need the pumps, removing the excess flood water in March. look at forest health from the 1950 to now. Look across the river and at other backwater projects that have pumps - all is well including the forests and wetlands. I ask you to please be careful when considering opinions of folks from other areas of this state and country. Be careful of those who are using this situation as a fund raiser for their organization. Even as professionals we tend to skew our thoughts based on our experiences where we live and work. I came from North Dakota and if you had told me there can be too much water in a wetland, I would have said you were lying. A friend of mine, very intelligent, is against the pumps because she says farmers pumping out of the shallow aquafer near her home south of Greenville caused their hand dug well to go dry. She could be right, but that is totally different pump situation. We have to believe in the science here. Some say let nature take its course. I do believe mother nature knows best. But when man has modified a watershed as large as the Mississippi River's to the extent we have, our only recourse is to try to imitate mother nature in small areas like the south delta. By removing the excess water caused by man, we can let mother nature take it from there. Remember the wetlands especially seasonal ones which much of them are in the Delta get filled by winter rain, not river flooding. And the annual cycle of these wetlands -- they are full in March and began to dry down through evaporation and percolation till the center is a mud flat in July. Each stage of the water level produces different vegetation communities in rings around the wetland. The moist soil plants will grow and be a buffet for the wintering waterfowl as the fall and winter rains begin to fill them up. Then in March the annual cycle begins again ---IF and ONLY IF the pump will remove the excess flood water WHEN NEEDED. Thank you for your time and effort to understand this complicated issue. And please push for option #2 which on the ground science has proven to be the best option for the bottomland hardwood ecosystems and wetlands we have here.	Comment noted, see responses to comments 1, 45, 67, and 90.
183	7/23/2024	General Public	Alternative	Alternative 2	See response to comment 1
184	7/23/2024	General Public	General Support	Good morning. My husband and I support Initiative 2 for finishing the pumps. We own Britton Furniture in Rolling Fork and the flood devastated our business for two years. I would stay at the store and hope customers would come in while my husband would go help sandbag in our area. Please help us save the Delta by finishing the pumps. We just went through a devastating EF4 tornado that destroyed our business. We have built back and are here to serve the Delta area for years to come. Please put the pumps in so we don't have to worry about flood waters ever again.	See response to comment 1
185	7/23/2024	General Public	General Support	I am a retired Corps employee who worked for many years at the Vicksburg District and finished my career at the Mississippi Valley Division Office. I was a Civil Engineer in Construction Division when the outlet channel for the pumping plant was constructed in the 1980's and after moving to Project Management, I was heavily involved in the project reformulation in 2007. So, I am very familiar with the purpose and history of this project. I have lived in Vicksburg all my life and am painfully aware of the devastation caused by floods in the lower Delta going back to the Flood of 1973. I have friends who live, work and farm in the South Delta, so I know how the floods have impacted them, especially the horrific flood of 2019 which kept the area under water for many months. My wife and I helped friends at Eagle Lake clean up the mud and filth that covered their property in August 2019. I have attended most of the public meetings that have been held over the past couple of years and have heard the passionate comments from many residents whose lives and livelihoods have been affected by the floods.	See response to comment 1
186	7/23/2024	General Public	Alternatives	I fully support construction of the proposed 25,000 cfs pumping plant and believe that Alternative 2 would be the best long-term solution to the water management problems in the South Delta.	See response to comment 1
187	7/23/2024	NGO-Audobon	NEPA	Good Afternoon Colonel Gipson and Mr. Renacker, With the conclusion of the Corps' public meetings earlier this week, Audubon would like to reiterate our request for an additional 45day extension of the public comment period for the Yazoo Backwater Area Water Management Project Draft Environmental Impact Statement; reattached is our July 3, 2024, letter. Thank you for your consideration.	See response to comment 4
188	7/23/2024	General Public	Alternatives	Areas of Concern: Home Accessibility, Housing or property impact, access to emergency services, impacts to wildlife, impacts to wetlands/environment, infrastructure (electricity or road accessibility) agriculture (flooding of farmland or loss of livestock), Hunting or Outdoor Recreation. Option 2.	Comment noted. See responses to commens 1, 91, and 113
189	7/23/2024	General Public	General Support	Areas of Concern: Housing or Property Impact	See response to comment 39
190	7/23/2024	General Public	General Support	Areas of Concern: Housing or Property Impact	See response to comment 39
191	7/23/2024	General Public	General Support	Areas of Concern: Home Accessibility, Housing or Property Impact, Access to Emergency Services, Impacts to Wildlife, Impacts the wetlands/environment, Infrastructure(Electricity or Road Accessibility), Agriculture (flooding of farmland or loss of livestock), Hunting or outdoor recreation. I am a retired navy vet and a current USACE employee.. and I just want to go home! My home is located on 4047 Goose Lake Road in Filter. I am unable to easily get to my house due to the bridge closure for 3 years, and my natural gas services was cut, without any notification. The alternative roads are terrible, and takes too long to get in and out of there. I have been out of my house since MAR 2, 2019. I want to go home but I need, at least the bridge fixed to do so. Others would come back if access was not so challenging.	See response to comment 1

Comment Number	Comment Date	Org.	Theme	Comment	Response
192	7/23/2024	General Public	Wetlands	Areas of Concern: Impacts to wildlife, Impacts the wetlands/environment. Option 2 will best allievate the problems this summer flooding is causing to our bottomland hardwood forest and wetland health in the South Delta	Comment noted. See responses to commens 1, 91, and 113
193	7/23/2024	General Public	General Support	Areas of Concern: Housing or property impact, Impacts to wildlife, Agriculture (Flooding of farmland or loss of livestock), Hunting or outdoor recreation. 2011-2012? Completely flooded- July 2018-2019? July-August 2019-2020? July-August	Comment noted. See responses to commens 1, 91, 113, and 503
194	7/23/2024	General Public	Prime Farmland	Could not farm/ no crop	See respones to comment 1
195	7/23/2024	General Public	Wildlife	Wildlife decimated/ not back to pre 2019	Comment noted. See response to comment 113.
196	7/23/2024	General Public	Economics	Effect property values Extensive damage to marketabke timber!	See response to comment 1
197	7/23/2024	General Public	Alternatives	Areas of Concern:Home Accessibility, Housing or Property Impact, Access to Emergency Services, Impacts to Wildlife, Impacts the wetlands/environment, Infrastructure(Electricity or Road Accessibility), Agriculture (flooding of farmland or loss of livestock), Hunting or outdoor recreation. I fully support Alternative #2 (except a mandatory buyout) to install a pump station for better safety, quality of life and a healthy environment for ALL inhabitants.	Comment noted. See responses to commens 1, 91, and 113
198	7/23/2024	General Public	Alternatives	Areas of Concern:Home Accessibility, Housing or Property Impact, Access to Emergency Services, Impacts to Wildlife, Impacts the wetlands/environment, Infrastructure(Electricity or Road Accessibility), Agriculture (flooding of farmland or loss of livestock), Hunting or outdoor recreation. I am voting for Alternative 2. Thanks for all of your coordinated efforts. The South Delta is so grateful.. and finally, hopeful.	Comment noted. See responses to commens 1, 91, and 113
199	7/23/2024	General Public	General Support	Areas of Concern:Home Accessibility, Housing or Property Impact, Access to Emergency Services, Impacts to Wildlife, Impacts the wetlands/environment, Infrastructure(Electricity or Road Accessibility), Agriculture (flooding of farmland or loss of livestock), Hunting or outdoor recreation, Adding danger to kids on school buses traveling levee w/ water on each side. You cannot finish something until it has started. So lets START the pumps so one day they will be finished.	Comment noted. See responses to commens 1, 91, 113, and 503
200	7/23/2024	General Public	General Support	Areas of Concern:Home Accessibility, Housing or Property Impact, Access to Emergency Services, Impacts to Wildlife, Impacts the wetlands/environment, Infrastructure(Electricity or Road Accessibility), Agriculture (flooding of farmland or loss of livestock), Hunting or outdoor recreation.	Comment noted. See responses to commens 1, 91, 113, and 503
201	7/18/2024	General Public	General Support	Sir, we need to get the pumps going. Floods destroy wildlife and timber. Thank you	See response to comment 1
202	7/29/2024	General Public	General Support	Please finish the pumps. We are all exhausted at this point of the game. We have tramped from one end of the Delta to the other. We are fatigued with the continuing saga with no end in sight. We have endured a total change of life here at Eagle Lake, a health impact due to the sand bagging we did to try to save our homes. We are desperately hoping this is going to be the end that results in a solution for our place we call home. Ladora & Larry Eubanks. Permanent residents.	Comment noted, see response to comment 1.
203	7/29/2024	General Public	General Support	I vote in favor of Alternative #2 and would ask that you please consider adjustments to the pump-on elevations and dates.	Comment noted, see response to comment 1.
204	7/29/2024	General Public	General Support	I am Angela Hudson a third generation farming and land owner and am in support of Alternative 2; Crop Season (16Mar-150ct) and non-crop season (160ct-15Mar) Structural: 25,000 CFS pumping station at Steele Bayou. I would like for you to consider adjusting the pump turn on to a earlier date.	Comment noted, see response to comment 1.
205	7/29/2024	General Public	General Support	I am Gloria Adcock, I have lived in the South Delta in Sharkey County all my life. My Father farmed for 60 years, and my husband and I have owed farm land most of our 64 year married life. My son leases my land now and continues to farm. My Grandson joined my Son and they continues to farm my land. My family has faught the backwater flooding for many years, some years have been worse than others, but every year flooding is a huge possibility. The installation of a pumping station at Steele Bayou is an answered prayer. I am in support of Alternative two. I would also request that you consider adjusting the pump turn on to an earlier date. That would give us a little more time for the land to dry, so the best crop yield can be achieved. Thank you for your consideration of Alternative 2 and adjusting the pump turn on to an earlier date.	Comment noted, see response to comment 1.
206	7/23/2024	General Public	General Support	To Programs-and-Project-Management: I was reared on a family farm off the old dummy-line road in Sharkey County. My dad cleared up a parcel of land approximately 1,640 acres starting in 1965 until we moved there in 1967. I still farm in Warren and Issaquena County. I am a second-generation advocate for the pumps and most thankful that all three agencies are working together so perhaps my son who is forty-two years old will not have to wait as long as I am waiting for the pumps! I have attended many meetings as well as the one last night July 23, 2024, at the city auditorium. I had several thoughts after talking with my friend Peter Nimrod but frankly I am worn down and tired of trying to explain why we desperately need the pumps. I was surprised by the low turnout of residents, employees, farmers and landowners but I can certainly relate to the repetitious comments year after year. Thank all of you foryourtime and effort as this project moves forward.	Comment noted, see response to comment 1.
207	7/23/2024	General Public	Alternatives	I would be in favor of the second proposal and hope there could be some adjustments to the water levels and stop/start dates. I farm corn, cotton and soybeans from Valley Park down to the canal and some years we are really late getting cotton out of the fields.	See response to comment 1
208	7/26/1900	General Public	Economics	This is just for information but our farm employees have asked to be put on guaranteed forty-hour week or a bi-weekly salary to make sure their family has income during extended backwater events. We started doing just that over a year ago!	Comment noted
209	7/24/2024	General Public	General Support	To Whom It May Concern: I am writing on behalf of a farmer cooperative located in Issaquena County just south of Valley Park. We have at present fifty-four active members and a customer base from Eagle Lake, Mayersville, Rolling Fork, Anguilla and Cary. I know there are a lot of areas in-between. Our cooperative delivers corn into the poultry industry in Mississippi and we truck soybeans to our barge loading facility on the Harbor in Vicksburg. My point being most of us farm and have employees and residents in the backwater area. We are and have been supporting the installation of Yazoo Backwater Pumps for years. We are basically a second-generation business that was started in 1967. Most of us grew up as the canal was being dug and seeing the gates finished in 1975 without the pumps installed. We have also been the recipients of many years of man-made flooding. We are excited to finally see the three governmental agencies coming together to perhaps "Finish the Pumps". Unlike surrounding states and the Northern Delta, we have the unfortunate risk of never knowing when or the extent of another flood. It is beneficial most years to plant early, however, in our area we have the unfortunate risk of not knowing when it is going to flood, the elevation it will flood and how long the gates will be closed as we wait for the stopper to be pulled like a bathtub drain. We are anticipating the pumps as well as alleviating some portion of that risk. Since 2019 we have seen soil erosion, drainage problems and the never-ending burden of trees dying and littering roads, power lines and fields. We very much appreciate all the time and effort the agencies have put into this project. Please let us know if we could be of help in any way.	Comment noted, see response to comment 1.
210	7/24/2024	General Public	Alternatives	We, as a group, support proposal two and welcome a discussion that modifies your water levels as well as the dates turning the pumps on and off	Comment noted, see response to comment 1.
211	7/31/2024	General Public	Alternatives	To the USACE, EPA, and all parties working on the flood relief that is an environmental and human injustice, My name is Diane Klaus. I have sent in a previous response, stood before the panel in Vicksburg and gave a small speech on the 2019 flood impact. After that meeting, I feel I did not go into detail about another impact the water causes. It was mentioned that roads would be raised to allow access for flood victims to travel while flooding is high. Unless those roads are protected with riprap the wave action from flooded fields will erode those roads as it did during previous flood events. Some of the damage done in those years have not been repaired and there are piles of large riprap that were placed on 465 near the Eagle Lake community to try and save a portion of that highway where two cross culverts are located. Mailboxes were also undermined, washed over and had to be repaired. Yes, the roads can be raised but if the water is high, the wave action WILL wash away the sides and the infrastructure raised will eventually fail too.	See response to comment 1. Additionally, a section has been added to the EIS regarding transportation.
212	7/31/2024	General Public	Alternatives	Again we need the flood protection with alternative 2, and the capability of lowering it more if needed. A large rain event will exceed the 90' very quickly.	Comment noted, see response to comment 1.
213	7/31/2024	General Public	Alternatives	Protect and save wildlife, communities, agriculture, infrastructure, businesses, and those who have invested their lives into their forever homes with no where to go. Don't treat us like the wildlife and trees that are dispensable any longer. We are human beings who want to live in peace and not fear our government forgets us again.	Comment noted, see response to comment 1.
214	7/31/2024	NGO-Sierra Club Mississippi	NEPA	CORRECTION--Updated letter attached. Hello--The MS Sierra Club is resubmitting our attached July 4 request for an extension of the Yazoo Backwater comment period on behalf of our 2,000+ members in MS; this is particularly urgent given the current Aug. 12 deadline. Please acknowledge your receipt of this email.	See response to comment 4

Comment Number	Comment Date	Org.	Theme	Comment	Response
215	7/31/2024	General Public	General Support	Good afternoon, My name is Melanie Stoner. I am a resident of HOlly Bluff, MS located in the South Delta. The flood of 2019 was a dark time for us in Holly Bluff and thos many other areas of the South Delta it was a time filled with fear, uncertainty and anxiety. It was especially ahrd for my husband Joe who suffered at the time form ALZ and for me too, as his only caregiver. Confusion is paramaount with ALZs and seeing our home surrounded by water like a reservoir only exacerbated his confusion. He was panicked that the flood waters were preventing our family from planting a crop adn that our livelihood was in jeapordy. And he had every reason to be panicked becasue we, in fact, did not plant our land that year the in the south delta. I beleive tht the stress of living through this 6 month ordeal accelerated to progression of his disease. Yes, stress will do that, and unfortunately it wasn't too long after the flood waters receded that sadly he passed away. We also lived through the constant fear that with the potential threat of rainy weather conditions, and the fact that our area was labeleed as that of a bathtub situation that our home would eventually be flooded as well. Thankfully, by the grace of God, it did not. . Some in the government and others ont eh outside suggest we ought to just pack up and abandon our homes and land that has been in our families for over a century. The land that incidentally as a major source of our income and livelihood. How would you feel if you were in our shoes and someone told you that?? How would you feel if you were told you had to leave everything that you had ever known? I have no doubt whatsoever that you would feel the the same exact way as we all do here in the South Delta. Especially when this all could have been avoided many many decades ago. I ask you to please do the right thing and finish our pumps so we can feel secure again knowing our home and livelihood are no longer being threatened by again, man made flood. Thank you fro your time today. Please do alternative do alternative 2 with earliear cut on dates. Thank you!	Comment noted, see response to comment 1.
216	7/31/2024	General Public	Alternatives	The threat of vandalism was another fear and consideration. That is why we chose to stay in our home throughout this hellish ordear, but it was not easy. Just imagine not being able to flush your toilet during this 6 month crisis. At that point, we had to resort to using camping style tactics. Use your imagination as to what that entailed. Believe me it was not pleasant and the while beiing the sole caregiver to my sick and confused husbant. No it was not easy. It was like living in a 3rd world country and it did not have to be that way. This is just one of the many situations we encounrtered that were terrible. I could go on and on for hours.	See response to comment 1
217	7/31/2024	General Public	Wildlife	Not only did we suffer horrible conditions but so did the poor wildlife. It was heartbreaking to see herds of starving deer running through the deep flood waters seeking high ground. Seeing their carcasses littering the landscapes as the water receded was a devastating sight. If you care anything about wildlife, you don't want them to have to endure a flood. They do not fair well contradictory to what some in the government and other may think.. We saw the horror with our own eyes. We lived it for 6 hard months. No human no animal should have to go through the horror of a flood, especially one that is categorically known to be man made by the US government.	See response to comments 45, 67, 90, 113, and 503
218	7/31/2024	General Public	Alternatives	Please do alternative do alternative 2 with earliear cut on dates. Thank you!	See response to comment 1
219	7/31/2024	General Public	General Support	Areas of concern: home accesibility, housing or property impact, access to emergency services, impacts to wildlife, impacts the wetlands/environment, infrastructure (electricity ro road accessibility), agriculture, (flooding of farmland or loss of livestock), hunting or outdoor recreation. Please finish the pumps with alternative 2 with earlier cut on dates.	See response to comments 1, 39, 45, 67, 90, 91, and 113
220	8/2/2024	General Public	General Opposition	I urge you to withdraw your effort to revive the environmentally catastrophic, grotesquely wasteful 'Yazoo Area Pumps Project' in Mississippi. No amount of NEPA hand waving can alter the dispositive, fatal errors of both fact and morality in the conceptual premises of the Yazoo Project. This project has lingered as a pet dream of major agricultural interests in Mississippi for decades, has been rightly and repeatedly rejected by the Army Corps and Engineers and the Environmental Protection Agency, including under the Bush Administration, because it would drain and eradicate 200,000 acres of the country's most precious wetlands in the watershed of Mississippi's Big Sunflower River. No facts have changed to warrant the Corps' attempt to evade or suborn this veto.	EPA implements CWA section 404(c) and issued the 2008 section 404(c) Final Determination concerning the Yazoo Backwater Area Pumps Project. USACE therefore cannot speak to the applicability of EPA's Final Determination. See response to comment 5.
221	8/3/2024	General Public	Real Estate	Rather than accept the implication of this fact, the Corps now seeks to subvert and disappear the long-established Clean Water Act review process for federal projects, nullify the considered judgment of agency scientists, and impose this gross caricature of home-state pork through raw political power. This represents an explicit demand for the liquidation of one of America's irreplaceable biological Edens, in exchange for barren, vacant land to produce low-value commodity crops. 200,000 acres of swamps, bayous, marshes, and bottomland forests will vanish, making a blatant mockery of repeated American commitments to staunch the loss of our wetlands. A more profane theft against our children and our Planet Earth, for the most venal, parochial, selfish of reasons could not be fathomed.	The decision to pursue mandatory acquisitions has been removed and now the document now consists of voluntary acquisitions. Aside from voluntary acquisition of property, additional nonstructural options such as home raisings are being contemplated. See response to comment 480.
222	8/4/2024	General Public	Engineering	The Environmental Protection Agency vetoed the Yazoo project in 2008, owing to the outlandish and gratuitous ecological destruction it would cause, and the utter lack of any public interest in constructing one of the world's largest water pumping complexes in a sparsely populated region. The Yazoo pumps would constitute a $300 million engineering subsidy to help landowners violently remake the landscape of Mississippi to their agricultural convenience. The pumps' sole purpose is to move up to six gallons of water per minute from one side to another of a Corps' flood control structure, to assist a handful of large landowners to increase production on lands that naturally, regularly flood and are inappropriate for agriculture. This area already receives several million dollars federal subsidies annually, the highest payouts in Mississippi, due to regular flooding.	EPA implements CWA section 404(c) and issued the 2008 section 404(c) Final Determination concerning the Yazoo Backwater Area Pumps Project. USACE therefore cannot speak to the applicability of EPA's Final Determination. See response to comment 5.
223	8/5/2024	General Public	Wildlife and wetlands	The Yazoo pumps represent a resurrection of a bygone era in hydrological engineering, deploying overwhelming force against the natural cycles, contours, and dynamics of the Earth's life support system. The wetlands that will cease to exist include jewels of the Delta National Forest and four National Wildlife Refuges in Mississippi, which the American people have invested dearly to protect for decades. More than 450 species of fish and wildlife, including 257 species of birds, rely on the wetlands to be drained by the Yazoo pumps. The public interest in maintaining these wetlands, and the right of the plants and animals to retain their homes in these wetlands, supersedes the avaricious, petty interests of agricultural interests in claiming a publicly subsidized production zone. These verdant, vibrant remnants of America's biological heritage defy any financial tabulation, and to deny our children the Big Sunflower River wetlands, as their rightful inheritance, would be a moral crime beyond any redemption for the Corps. It would serve no purpose but to surrender more fragile floodplains to production of more of the commodity crops from which America is already suffering a gross overproduction, and for which USDA already pays millions to render economically viable.	The proposed Alternatives 2 and 3 would allow for backwater flood events to reach the entirety of the 5-year floodplain during the non-crop season in years when flood elevations on the Mississippi River necessitate closure of the downstream water control structures (e.g., Steele Bayou) and sufficient precipitation occurs within the Yazoo Backwater Area to induce a 5-year flood event. Additionally, these alternatives allow wetland hydrology to persists within the 2-year floodplain throughout the crop season when the conditions noted above occur. The analysis was conducted using the assumptions that all areas subject to as little as one day of flood inundation are functioning as wetlands and that all non-agriculture lands experiencing flooding are highly functional mature forested wetlands. The extensive monitoring and adaptive management plan will include long-term monitoring of conditions within the study area to ensure that 1) impacts to wetlands were not underestimated, 2) any potential unanticipated impacts to wetlands can be quantified and addressed, and 3) the establishment of wetland mitigation successfully offsets impacts to wetlands resulting from project implementation. The selected approach along with the considerations noted above promotes the responsible management of the valuable wetland resources in the Yazoo Backwater Area.
224	8/5/2024	General Public	Alternatives	Rather than spend $300 million on crude, brittle, sprawling water engineering that would be only marginally effective by the Corps' own admission, the federal government could compensate agricultural landowners by a similar amount to fallow their inappropriately located cultivation, and allow this flood-prone land to return to marshes and forests. This would fully eliminate financial risk for the relevant farmers, immensely benefit the wetland ecosystem species that have already lost so much Mississippi River wetlands, and restore wetland functions of absorption and storage that will mitigate risk to remaining landowners. The superiority of a natural restoration alternative to the Yazoo pumps fiasco is obvious by every metric, and should have concluded the NEPA process years ago.	See response to comment 1
225	8/5/2024	General Public	General Opposition	Again, I urge you withdraw this effort to resurrect this ecological, moral, and fiscal travesty known as the 'Yazoo Area Pumps Project,' and accept the prior EPA veto, whose warrant has only increased since 2008, as wetlands have continued to retreat across America before human consumption. The project exemplifies the very worst of parochial engineering on behalf of narrow agricultural interests, rendering the Corps a private engineering service to subsidized floodplain farmers. The selfish, parochial demands of the Mississippi delegation are to be expected from politicians advocating their wealthiest constituents' expropriation of public resources, but bear no relevance to your consideration of the American public interest.	See response to comment 5
226	8/5/2024	General Public	Alternatives	Thank you for the opportunity to share my thoughts on this issue. Our farm is located on the Sharkey/Washington County line. Over the years, when we have experienced severe backwater, we have only had high ridges out and had to build up levees around our houses and grain bins. Allowing a pumping station can alleviate this. If we are concerned about pollution, why are we not addressing drainage all other times of the year. The whole system needs to be changed. Weirs in canal ditches, dredging the Big Sunflower, etc. We've built a system to shoot water quickly into the river. Without an outlet, it's a disaster every time we have high river/excessive rainfall. If a pump isn't going to happen, start at the head of the Big Sunflower and work your way down with weirs on all large ditches, etc to mitigate run off. Dredge the Big Sunflower. Put a weir in the Bogue Phalia. Let the sediment do the work in backfilling these huge ditches to clean up runoff and then let's revisit the pumps with a clean waterway.	See response to comments 1 and 229
227	8/7/2024	General Public	General Support	My name is Jason Cummins, I am a lifelong resident of Warren county Mississippi and currently reside in the Eagle Lake community at 315 Shell Beach Road. I am employed at Lamb Weston in Delhi, Louisiana and consider myself an avid outdoors enthusiast. I enjoy the natural beauty of the Yazoo Backwater Area and the life that it provides for my family. I've also experienced firsthand the devastation that the flooding events has caused for this area. Especially the 6-month flood of 2019. The unknown of when it will occur again is frightening but even with that the joy the area brings to me, and my family outweighs the fear. Through the years, I've attended every meeting about flood control in this area and have more hope now than ever that we are finally making progress. I fully support the Proposed Water Management Solution that includes the pumps with an operating scenario in Alternative 2.	See response to comments 1, 67, 90, 113, and 503

Comment Number	Comment Date	Org.	Theme	Comment	Response
228	8/12/2024	US Department of Interior	Recreation	The Department jointly administers the Land and Water Conservation Fund (LWCF) with state agencies and therefore retains authority to advocate on behalf of these resources. Per the LWCF Manual, "Property acquired or developed with LWCF assistance shall be retained and used for public outdoor recreation. Any property so acquired and/or developed shall not be wholly or partly converted to other than public outdoor recreation uses without the approval of National Park Service (NPS) pursuant to the LWCF Act (54 U.S.C. § 200305(f)(3)) and conversion requirements outlined in regulations (36 C.F.R. § 59.3)." Situations that trigger a conversion include: a. Property interests are conveyed for private use or non-public outdoor recreation uses. b. Non-outdoor recreation uses (public or private) are made of the project area or a portion thereof, including those occurring on pre-existing rights-of-way and easements, or by a lessor. 2 c. Unallowable indoor facilities are developed within the project area without NPS concurrence, such as unauthorized public facilities and sheltering of an outdoor facility. d. Public outdoor recreation use of property acquired or developed with LWCF assistance is terminated. The Draft EIS identifies a number of LWCF properties within the study area (Table 4-9 & 4-10); however, based on the analysis, it is unclear of the extent to which there might be potential conversions of these properties. The Final EIS should specifically identify the extent to which there would be any potential conversions. If any part of an LWCF property will be removed from outdoor recreation as a result of this project, the NPS and the Mississippi Department of Wildlife, Fisheries, and Parks or the Louisiana Department of Culture, Recreation and Tourism will need to be notified and consulted so the conversion of use can be satisfied following LWCF regulations and policies. Additionally, Tables 4-9 and 4-10 identify LWCF properties created between 1965-2011. The tables should include LWCF properties through the current year, or a statement to explain that there have been no new LWCF properties since 2011 should be included. Finally, the Department notes that the source link for Table 4-9 is broken and requests that the Final EIS include a usable link.	Acknowledged. Tables 4-9 & 4-10 have been updated respectively to reflect the most recent data as recommended. The recreation resource section has been updated to address LWCF properties within the YSA. There would be no conversion of existing LWCF properties from public outdoor recreation use. Coordination with MDWFP and the NPS would continue throughout the design and implementation phases to avoid and minimize any potential impacts to existing LWCF properties.
229	8/12/2024	General Public	Pump Operations	Thank you for your collaboration to produce the report. The 2019 Flood demonstrated that without a pump station, 70 percent of the wildlife will die along with severe damage to trees and habitat, along with a gut punch to the quality of life of all inhabitants. The high turn-on elevation of 93 in March will increase the probability that heavy rains will cause higher peak elevations and extended days or weeks to pump down to 90. With wetter years in the forecast, the repeated years of higher stages may devastate the hardwood forests that dominate the lower portion of the basin. Please consider designing the pump intakes to be able to pump at elevation 87 to provide the capability to alter the management plan if lower levels are required to reduce stress to the forests. Please revise the authorization language to include the flexibility to adjust the turn-on dates and elevations. While I choose Alternative 2, repeated years of flooding may demonstrate that earlier and lower turn-on levels are warranted.	See response to comments 1, 45, 67, 90, 113, and 503
230	8/13/2024	General Public	Engineering	The management agreement for Eagle Lake is a maximum of elevation 76.9 and a yearly drawdown in the fall to 75.0. Lowering the lake is critical to sustaining the trees in the lake and to reducing lakefront property damage due to overly high stages. Operation of the Muddy Bayou Structure gates has been severely restricted to prevent Asian Carp from entering the lake. Invasive fish species such as Asian Carp surely comes under your broad definition of ecosystem damages. Please consider including a fish-entry barrier system to the Muddy Bayou Control Structure in the ecosystem mitigation portion of the project. This barrier will allow full operation of the gates to ensure that the lake can be lowered each fall. In doing so, Eagle Lake will be protected from invasive species and flexibility will be added to managing the low water pool of the backwater. The barrier could be as simple as a bubble system run by a 250 cfm portable compressor or heavy screens placed in the slots for the stop logs. The flooding of the lake in 2019 demonstrated the stress on the trees by killing hundreds of cypress that have thrived for 50 to 100 years or more. The high stages in the lake this year has killed several dozen more. The lake has been maintained above the 76.9 level since March presumably to allow young fish to seek shelter among the trees. However, the stress has killed several dozen of the trees located in the deeper water. Trees that will never be replaced and form one of the key beauties of the lake. Protecting one year's fry is extremely short sighted when it causes permanent damage. Instead, the wise move is to lower the average stage of the lake for a few years to allow the stressed trees to recover. The backwater begins flowing into Eagle Lake near Tara most likely below elevation 93. Please consider adding gates to key culverts and raise farm roads to prevent this over-land flow into the lake. The capacity of the proposed Pump Station will allow control of the duration of floods. Please allow flexibility in your Management Plan to adjust the hardwood forests become severely stressed. Prolonged stages at 90 will kill the hardwoods. Wise use of the Pumps can prevent this. I deeply appreciate the efforts of this team and your willingness to take time to meet with us. Sincerely, Ken Klaus, Eagle Lake, MS	Comment noted. Muddy Bayou structure is normally closed to prevent turbid waters from Steele Bayou entering Eagle Lake, while during floods, the structure can be opened to reduce pool elevations in the lake. The stated purpose is to enhance "water quality and fishery resources and also provide incidental flood protection for properties along Eagle Lake." Operation of Muddy Bayou Structure is coordinated with Mississippi Department of Wildlife, Fisheries, and Parks (MDWFP), who manages the fisheries in Eagle Lake. Currently, the structure is only raised a maximum of 15 cm to maintain high water velocities exiting Eagle Lake that exceed the published burst swimming speed of Silver Carp. Application and coordination of management and control strategies such as the barriers mentioned in the comment are being developed by the Invasive Carp Regional Coordinating Committee and includes the Lower Mississippi River drainages. (https://invasivecarp.us/about-ICRCC.html) and MDWFP.
231	8/14/2024	General Public	General Support	Sometimes it feels like people think this issue is farmers against environmentalists. With the farmers saying the pumps will help farmers and local residents and the environmentalists saying the pumps will hurt the environment. As a conservationist who lived and worked as a biologist and in forest management in the South Delta for nearly 20 years, I am saying the pumps will help the hardwood forests and associated wetlands. The degradation of the Bottomland hardwoods and associated wetlands due to the lack of pumps is so evident – Look at Delta National Forest. Farm crop growing seasons are mentioned, but not hardwood forest growing seasons and not wetland vegetation growing seasons. All plants have growing seasons and only truly aquatic plants can grow and be healthy when under or in standing water during their growing season. Cypress are not even truly aquatic plants and need to dry out sometime. Please find attached a diagram and a story "My Wetland" depicting what should happen in the seasonal wetlands in the South Delta and what happens when the backwater flood water has been held up behind the gates due to the lack of pumps during the growing season. No one is advocating removing normal rain water that filled these wetlands during winter rains; just removing man made flood water. I am also attaching a diagram of a cross section of Delta National Forest with flood waters standing at elevations associated with the backwater flooding. Please note I have not been able to get exact topography and tree heights on the same diagram. The elevation differences max out at about 10 feet while the trees can be 100 feet tall. I am working on a way to show this more accurately, but it does show the problem with holding water at 93 and above into the growing season. The hardwood ridges need to be above the water or saturation line by March so the roots of the hardwood trees can dry out and be healthy. As the water lowers due to percolation, evaporation, vegetation uptake and normal draining, vegetation that can tolerate ground saturation later in the year (its growing season) will leaf out and flourish later in the year as the normal water goes down. If water levels are held above the elevations of the side slopes, steps, bottom slopes and bottoms, no vegetation can grow and produce seed causing irreparable damage to the wetlands and associated wildlife dependent on that vegetation to feed, shelter and raise young.	See response to comments 1, 45, 67, 90, 91, 113, and 503

Comment Number	Comment Date	Org.	Theme	Comment	Response
232	8/14/2024	General Public	General Support	Please note this is documentation to justify a pump and option #2 as the best alternative for the wetlands and their associated plant communities. However, I am afraid that with the elevations noted and start date of the pumps in this option, we will still have degradation of the wetlands especially in Delta National Forest and other hardwood bottoms of the same elevation. •It seEms that the general consensus is that the pump will be bad for the wetlands in the South Delta and mitigation is needed if the pump is put in place. This is just not true. The pump will help the wetlands be healthier because the excess water will be removed and the normal drawdown of the water levels can occur. •This project includes adding low flow wells in the north part of the Delta which is benefitting the aquatic ecosystems throughout the Delta – Why do we have to mitigate for this good feature of the project? •Working on Delta National Forest in 1990, I thought the bottomland forest was so beautiful. I was told by other professionals (wildlife and forestry) as well as "old timers" that grew up and hunted here "you should have seen it in the '50s and '60s." And as I look at it now in the 2020's I think how poor it looks compared to the 1990's. It is obvious to a trained eye that this backwater flooding is degrading the forest ecosystems here in the South Delta. •In 1990 I was told that the "flooding" was causing forest species composition shifts and reduced species diversity by a forester on Delta National Forest. As I watched the water levels in these different ecosystems in the South Delta over the past 30 years, I can see why. The water is not receding or drying up during the growing season thus causing individual species (like the pond berry) and whole communities to die out. How can anyone say this water is good for the wetlands. •If I have heard it once, I have heard 1000 times "the plant communities in the South Delta evolved with flooding; they will be fine" NO, NO, NO, NO!!!! The South Delta did evolve with flooding – WINTER FLOODING! And with winter flooding, I agree they would be fine. BUT this is not winter flooding, it is flooding during the growing season and they will not be fine with summer flooding. •When talking about this situation folks talk about the growing season and mean the farm crop growing season. ALL PLANTS HAVE A GROWING SEASON, this man-made flooding is preventing the bottomland ecosystems to thrive because they are flooded during their growing season. •When I try to explain the situation of too much water over these hardwoods I use a beaver dam as an example. I am not saying beaver dams are bad, but it can be used as an example to understand this. When beavers dam up a drain, it causes water to stand over the trees throughout the year. After several years the hardwood trees standing in that water die. The beaver did not kill those trees directly by chewing on them or cutting them down. They died because their roots were underwater too long. Roots of hardwood trees need to be aeriated during their growing season. Some will hang on longer than others especially if they are on higher ridges and around the edge of the beaver dam where they might dry out some each year, but they will be unhealthy. This is a perfect example of what is happening to the hardwood trees here in the South Delta due to the backwater flooding. •Pondberry colony numbers are down from those observed and followed from the 1990's to the 2020's, by close to 70%. Why, flooding during the growing season. They can not leaf out and recharge stores in their roots to flush the next year if they are under water for the majority of the growing season. •Recent research from Stoneville showed that pondberry can tolerate flooding for 90 days – in Jan to April. They did not evaluate colonies flooded 90 days in June through August. I think we know why, that is not when they were normally flooded. •Research was done in 2008-11 (I think) to evaluate if the pumps would or would not hurt the pondberry. The study found that the pumps would not hurt the pondberry. Unfortunately, this study did not have the option to say the pumps would help the pondberry. I think we see now if that was an option, the study would have concluded that the pumps would help the pondberry. •There is concern that water released from the South Delta area will add to the overload of fresh water flowing into the gulf which caused major problems to the saltwater ecosystems several years back. I'm wondering if the pump is put in place and the water would be released from the Delta area earlier than the majority of fresh water from farther north, would this actually do less damage than without the pumps. •There was extensive sediment movement into drains and wetlands from the farm fields due to the high water in 2019 and 2020. The wave action of the water setting on the fields throughout the summer moved soil as evident to deposits on roads which had water splashing onto them during heavy winds. •I understand some people feel that the South Delta should be put back into trees and then a pump would not be necessary. Of course, this option does not take into consideration generations of families that have lived and want to live here. But also, it doesn't consider that trees cannot tolerate the back-water flooding any better than the farm crops. •This is a man-made problem and has a proven man-made solution. The success of the pump is not speculation. There are other projects just like this one in similar situations and they have residents, farmland and functional healthy wetlands within their levee systems. •I've heard people say let the science dictate what needs to be done. Representative Bennie Thompson even put this in a letter to the EPA. I agree, but the science has to be from here in the South Delta. And we have the science from here that proves the pump is necessary for the wetland ecosystems present. •I am concerned that Audubon says that installing the pump will destroy 200,000 thousand wetlands which support 250 bird species and they specifically mention waterfowl. I can't find the 200,000 acres that will be destroyed. As for the waterfowl, from what I experienced, the high water in 2019 and 2020 negatively affected waterfowl because it prevented vegetation growth that provide food for the wintering waterfowl. The pump could have reduced the flooding, allowing for wintering waterfowl foods to grow. •I hate that the USFS and the NRCS as other agencies that are aware of the devastation caused to the environment due to the lack of pumps can not weigh in with their knowledge because they are not allowed to because it is a political issue. As I see it putting the pumps in and removing backwater flooding as early as possible is a win, win, win, win… situation. Who will win? In the South Delta the breeding and wintering birds, resident mammals, reptiles, amphibians, fish, butterflies and other insects, plants and the whole bottomland forest ecosystem, Delta National Forest (which by the way is the only 100% bottomland forest the USFS has,) the endangered pondberry, farmers, residents you name it will benefit. Even the wetland ecosystems in the North Delta will benefit from the low flow wells. I don't mean to sound condescending; but, if anyone opposes the pumps and the earliest possible turn-on date they are just not familiar with what is happening here. Their opposition is hurting the very thing they say they want to protect. I came from North Dakota and before I lived and worked here as a biologist and forest manager, I might have felt the same way. But trying to manage land and seeing the devastation due to the lack of the pump, I just want to scream and cry at the loss of habitat and wildlife here in the South Delta. Please confirm option 2 as the only viable option for the Yazoo Backwater flooding issue.	See response to comments 1, 45, 67, 90, 91, 113, and 503

Comment Number	Comment Date	Org.	Theme	Comment	Response
233	8/14/2024	General Public	General Support	To whom it may concern. This is a justification for the Yazoo Backwater Pump to be completed and why option #2 is the best option. As a waterfowl biologist and hunting guide I want to tell the story of degradation of the South Delta wetlands over the last 50/60 years. It begins when the Yazoo Backwater Project was almost finished … but the last piece -- THE PUMP -- was not constructed. Many people that have not lived and worked with wetlands extensively believe that wetlands need water (the more the better – right?) And if you remove water, you destroy wetlands. As crazy as it sounds this is not always the case. It depends the type of wetland, how much water it needs and what season it needs to be wet and/or dry. Most of the wetlands here in the South Delta are not permanent, but seasonal wetlands. Historically they fill during winter rains, and were dry by July. The periodic spring flooding of the Mississippi River in past centuries did not have a significant impact on the annual filling of these wetlands. If the River did overtop is banks, the flood waters rose over the already full wetlands and the ridges around them for several days in early spring, then drained out quickly. My Wetland Story summarize seasonal or monthly changes to a wetland in the South Delta during a normal water event and how the vegetation, wildlife and in particular waterfowl adapted to this natural rhythm. Introduction Think about a soup bowl you get in a fancy restaurant. The outer rim represents the ridges where the hardwood trees such as willow oak, water oak, sweetgum, green ash and sweet pecan make up the forest overstory. Maples, mulberry, pawpaw and winged elm are in the understory. Then there is the upper slope from the edge or ridge that goes down to a step or flat (the chef sprinkles the parsley or other herbs on this flat in your soup bowl.) On this upper slope in my wetland there is a transition of overstory species. There is willow oak, sugarberry, scycamore, nuttal oak, water hickory, persimmon and overcup oak. In my wetland, parsley doesn't grow on the step or flat, but cottonwood and willow dominate this area. There is another slope to the bottom of the wetland (or bowl where your soup is.) The difference between my wetland and your soup bowl is that the wetland has ridges in the bottom, most less than a foot high, but significant none the less. Plus, my wetland it is not round, but elongated because it's the ruminant of an old oxbow lake. On the bottom slope and the ridges in the bottom of the wetland the cypress and buttonbush grow. The flat bottom of my wetland (where your soup is) does not have woody overstory. It dries up too late in the year and too fast for trees to grow. But that's ok, it is ideal for warm season plants like grasses and sedges. And let me say that is really good for wintering waterfowl. My story describes the annual cycle of my wetland in a historical and/or normal water annual event. MY WETLAND'S STORY Starting in early spring say February/March, my wetland is full from the winter rains as are other wetlands in the area. In the past, if the Mississippi River flooded, my wetland was topped with this flood water, but it left quickly as the River receded. At this time the upland mid-story and understory vegetation around my wetland sprouted quickly to gather the sunlight before the hardwoods leaf-out and blocked the sun from getting to the forest floor. And before you know it with the flood water off the ridges, the overstory trees leaf out also. My wetland is still full of water. March comes and goes, water in the wetland soak into the ground and begins to evaporate due to the warmer, sunny weather. The upper slope of the soup bowl begins to emerge as the water goes down. There is a new flush of green; different types of trees, shrubs and herbaceous vegetation grow on this upper slope due to timing of when the water leaves. During April again, evaporation and infiltration lowers the water in my wetland. The bottom of the upper slope is now greening up; and another vegetation community will ring my wetland in this area. In May we have "snow storms" of willow and cottonwood seed floating on the winds trying to find a place to land and germinate. With the water levels dropping and the step becoming a mudflat, it is perfect timing for these trees to get started! If there are already cottonwood and willows established the seeds will germinate providing food for deer and other animals, but they won't make it through the year. They need full sunlight to survive. Willow tree leaves are thin and drooping and cottonwood leaf petioles are flattened so their leaves hang down also, allowing for some sunlight to reach the forest floor. This small amount of sunlight allows the seedlings, smart weed, beaked rush and other ground cover to germinate grow. This vegetation is so important for wintering waterfowl and other animals that live in and around my wetland. As June progresses, the lower slopes of my wetland are now drying out. On these slopes and on the ridges in the bottoms is a cypress/buttonbush community. Buttonbush thickets form at the base of the cypress and on the ridges in the bottom of the wetland. These species can tolerate a lot of water, but not if it overtops the tips of the plants and stay too long into to July. The hot water will actually scald young trees and shrubs. Sedges and rushes also take hold in these areas when the water leaves at the right time. And then July comes to my wetland; and it is hot and dry. The bottom of the wetland is now a mud flat; grasses, millets and other warm season vegetation begin to grow. They have to grow fast, the bottom dries so quickly that they don't have much time before the moisture is gone. Woody vegetation doesn't grow in the bottoms, the season and moisture dictate what grows here. By the end of July, the plants we call moist soil plants have matured and produced a layer of seeds sometimes inches thick in these bottoms. As I walk through my wetland at this time the seeds poof up like clouds of dust on a country road. This seed bank is so important for the wildlife especially waterfowl and it NEEDS to be here in the bottom, not on the slopes or ridges, trust me you will find out why as you continue to read my wetland's story. Now it is August, the bottom of the wetland begins to crack the moisture goes deeper and deeper into the ground. Cracks as wide as 6 inches and several feet deep are present in some areas in the bottom of my wetland. Nothing is growing, but the feast is laid in preparation for winter. September bring early fall rains. The cracks close as the moisture gets closer and closer to the surface of my wetland bottom. All other levels of the slough; bottom ridges, lower slope, the step and upper slope and ridges have seeds maturing. It is so exciting to imagine what will happen this winter. There are a few places in my wetland that has several inches of water standing; just enough for the Blue-wing Teal to stop and fill up and rest on their migration to the southern tip of South America. October and November bring more rains and water deepens in my wetland; up to 12 inches or so. Mallards, Wigeons, Gadwalls, Green-winged Teal and more arrive for their winter stay. All those seeds are there for them to feast on through the winter months. December and more rain. Now the water in the slough bottom is too deep for the dabbling ducks to get the seed; but that's ok, they probably already ate most of it and now the water depth on the bottom ridges and lower slope is just right for them to get button bush and other seeds dropped there. January rains raise the water into the willow/cottonwood flats. The ground vegetation there is very leafy and it and the willow and cottonwood leaves and branches are perfect for aquatic insects to live. Waterfowl at this time are preparing for molt, migration, and egg production. The birds need these insect larvae for the required nutrients. Ducks are also beginning to make pair bonds, the deeper water around the buttonbushes and the willow and cottonwood trunks are necessary for seclusion. Its February again, water is now near the top of my slough, ducks are utilizing seeds and acorns in this area as they migrate out to their summer nesting grounds. The cycle ends and a new one can begin. But…. do you know what happens to my wetland during years when the Yazoo Back Water pools up against the structure. 2019 and 2020 were the worst I ever saw. Winter rains filled up my wetland like any other year. BUT, then the backwater flooded on top of the winter rain water. It was so high it was at least 10 feet deep on the ridges around my wetland. March came and went, the water remained. The understory plants on the ridges did not sprout, the over story trees did. At this time water around their roots can still be tolerated. April came and went, the water remained. The understory plants on the upper slope did not flush, some understory trees and shrubs were completely under water. Now the ridge species of hardwoods were feeling the effects of warmer water and no aeration around their roots. May came and went, the water remained. Cottonwood and willow seeds never landed on mudflats, so they didn't germinate to provide food for deer, rabbits and other herbivores. Understory and ground nesting bird could not nest, their habitat was still under water. Turkeys remained in the trees constantly moving around looking for dry ground to nest, their bodies weakening from lack of quality food. The Mississippi River Levee is near my slough and it was not under water. All the animals and ground nesting birds that could sought refuge on the levee, but there was not enough area or protection. Turkey, and other ground nesting birds as well as rabbits and other prey species were killed by predators. My wetland was still under water in June and July; briers did not grow, cane was under water and did not sprout, no vegetation grew in or around my wetland. On the levee, most animals died of starvation if not preyed upon. Dead deer were everywhere, even raccoons and turtles and other animals that sought refuge on the levee were starving or being eating. Finally, the Steel Bayou Gates were opened and the flood waters began to recede. But it was too late for understory, and ground cover to grow in my wetland. The bottom never did completely dry out, so nothing grew there. When the winter rains came there was no seeds for the wintering waterfowl. They had to move on to other areas to find food and they had other birds there, to compete with. This excessive flooding is not something the vegetation and wildlife in my wetland and others in the South Delta can withstand. The bottomland hardwoods weaken and many die or fall because their roots are rotten from the flood water over their roots in the growing season. Cottonwood and willow will also become weak, buttonbush and other understory species will not survive. The ecosystem of my wetland and other wetlands are weak and sickly. For my wetland and others to be healthy and functional here in the South Delta, the EXCESS flood water due to the incomplete Yazoo Backwater Project has to be removed by the end of March, so the normal winter rain water can slowly lower as it needs to. The wetland vegetation needs the pump as much as the farm crops do. THE WETLANDS WILL STILL HAVE WATER LIKE THEY SHOULD because the pumps will only remove the excess back water. Wetland species like bottomland hardwoods and other plant communities in the South Delta have a growing season, they need be free of water during that time. Thanks so much for listening,	See response to comments 1, 45, 67, 90, 91, 113, and 503

Comment Number	Comment Date	Org.	Theme	Comment	Response
234	8/15/2024	NGO-TNC	EJ	Eighty percent of the population located within the Yazoo Study Area (YSA) primarily consists of low-income and disadvantaged communities. As stated in the DEIS, the region's per capita income is less than $19,000 annually and the average unemployment rate is 3-5% higher than the state unemployment rate. The severity of the issue from a socioeconomic standpoint is apparent; without a change in water management, these communities will continue to be adversely impacted and the effects on minority and low-income areas will be disproportionally high. For residents living within the 2-year floodplain (90ft), the proposal recommends mandatory acquisitions of all structures including approximately 55 residential structures. With respect to residents of the YSA, the Conservancy recommends continued dialogue to address mandatory vs. voluntary acquisitions within the 2-year floodplain. As it relates to downstream communities, modeling in the DEIS suggests that there are no adverse impacts due to structural components of the project. Modeling was based on additional water pumped from the YSA into the Yazoo River during the peak of the Mississippi River flood in 2011. The additional water capacity from a 25,000cfs pump resulted in minimal impacts registered on the Vicksburg gage measuring 0.4 feet.	Comment noted. However, mandatory buyouts outs will no longer be part of the Plan. Voluntary buyouts and dry-flooding of residential properties will be offered to those in the below 93 flood extent.
235	8/15/2024	NGO-TNC	Mitigation	The Conservancy supports securing all compensatory mitigation sites prior to construction of the project. After project completion, we believe it is'important to continue monitoring the pump station operations and analyze long-term efficiency to validate the project's successes. We recommend an adaptive management approach that allows for science-based operational guidance.	Comment noted.
236	8/15/2024	NGO-TNC	Alternatives	We believe that plans being considered without structural components, due to their inability to reduce flooding from the landscape, are not practical and provide limited benefits to the region. The Conservancy supports moving forward with the water management plan that best alleviates chronic flooding and provides benefits to both people and nature.	Comment noted, Alternative 4 has been screened, USACE proposes moving forward with alternative 3 as the recommended plan.
237	8/15/2024	NGO-TNC	General Support	RE: Notice of Public Comment period for the Draft Environmental Impact Statement for the Yazoo Backwater Area Water Management Project Dear Colonel Gipson: Please accept the following as The Nature Conservancy's, Mississippi Chapter, comments on the Draft Environmental Impact Study to Yazoo Backwater Area Water Management Project. The Nature Conservancy (the Conservancy) is a global organization dedicated to conserving the lands and waters on which all life depends. Guided by science, we create and support innovative, on- the-ground solutions to our world's toughest environmental challenges to ensure that nature and people can thrive together. We use a collaborative approach that engages local communities, governments, the private sector, and other partners. In Mississippi, we've worked with both private and public partners for more than 40 years to conserve over 165,0000 acres of land and water across the state. During this time, the Conservancy has worked to conserve and restore wetlands in the Yazoo River Basin, while also helping to establish numerous National Wildlife Refuges and Wildlife Management Areas across the Mississippi Delta. Due to prolonged and reoccuning flood conditions and associated harmful impact on both people and nature, the Conservancy suppo1is moving forward with a proposed flood control measure that alleviates chronic flooding and provides habitat benefits through structural and non-structural components. The southern portion of the Mississippi Delta continues to experience significant flooding that negatively impacts the sunounding communities, economies, and natural resources. Historic flooding in 2019 and 2020 resulted in fatalities, hundreds of millions of dollars in damages, significant impacts to wildlife, and flooding of nearly half a million acres and hundreds of homes. Current climate projections indicate the number-of extreme weather events will become more frequent and reflects that the status quo is no longer a viable option for the region's natural resources nor its residents. Over the years, this project has seen many renditions, which has led to the unprecedented interagency collaboration between the U.S. Army Corps of Engineers, the U.S. Fish & Wildlife Service, and the U.S. Environmental Protection Agency. We believe the proposed plans for both Alternative 2 and Alternative 3 include sought out solutions that incorporate and respect the thoughts, concerns, and experiences of the Yazoo.Backwater Area residents, while also staying in compliance with the Clean Water Act, National Environmental Policy Act and other applicable laws and regulations. These plans include a suite of structural and nonstructural components including pump stations, seasonal pump operations, low flow wells, buy-outs, and structural floodproofing.The Conservancy recognizes that many things have changed across the Mississippi River Basin since Congress authorized the cunent system of flood control measures along the Mississippi River in 1941. There is a dire need for a more effective long-term approach to water management across the entire basin. The severe impacts of the 2019 flood heightened collaboration between federal agencies and focused attention and resources within the federal government, prompting renewed interest in the development of a solution for the Yazoo Backwater Area. These proposed solutions provide significant flood risk reduction for communities and local economies while also minimizing impacts to the environment. The Conservancy remains available to offer its resources and assistance moving forward in both the Yazoo and larger Mississippi River Basins. We appreciate the collaboration and persistence of the U.S. Corps of Engineers, the U.S. Fish & Wildlife Service, and the U.S. Environmental Protection Agency. In response to previous criticisms, the 2024 Draft Environmental Impact Statement (DEIS) provides a new wetland analysis which encompasses a larger study area that includes the entirety of the five-year floodplain. According to the DEIS, there are no estimated changes to convert wetlands to non-wetland habitats. Also included in the proposed alternatives are the installation of 34 supplemental low flow wells along the mainstem levee of the Mississippi River. These proposed wells could improve minimum base flows, enhance habitat, and improve standing stock for aquatic species throughout the watershed. Due to increased water withdrawals associated with agricultural production, the region continues to experience low to no flow conditions throughout the fall season.	See response to comments 1, 45, 67, 90, 91, 113, and 503
238	8/16/2024	NGO-EPN	H+H	On June 28, 2024, the Army Corps of Engineers (ACOE) issued a draft Environmental Impact Statement (EIS) that includes a modified plan to address flooding in the Yazoo Backwater Area. This plan (the 2024 proposed plan) includes large pumps adjacent to the Steele Bayou structure to remove water from the backwater area that could potentially drain and impact up to 97,000 acres of wetlands, including wetlands identified in the 2008 Clean Water Act (CWA) Section 404(c) Final Determination (2008 Final Determination).	EPA implements CWA section 404(c) and issued the 2008 section 404(c) Final Determination concerning the Yazoo Backwater Area Pumps Project. USACE therefore cannot speak to the applicability of EPA's Final Determination. See response to comment 5.
239	8/16/2024	NGO-EPN	NEPA	The 2024 proposed plan includes a proposal to fully develop a pump operating regime, limited proposed mitigation, and limited structural alternatives. The 2024 proposed plan has the same or similar impacts as the plan that was identified and prohibited in the 2008 Final Determination. It also has similar impacts as the 2020 proposed plan which EPA later found were also prohibited under the 2008 Final Determination. As discussed below, consistent with our position in 2020, EPN is focused on the fact that the 2024 proposed plan is prohibited by the 2008 Final Determination. In addition, if ACOE would like to seek to modify the 2008 Final Determination, it has not taken the appropriate steps	EPA implements CWA section 404(c) and issued the 2008 section 404(c) Final Determination concerning the Yazoo Backwater Area Pumps Project. USACE therefore cannot speak to the applicability of EPA's Final Determination. See response to comment 5.

Comment Number	Comment Date	Org.	Theme	Comment	Response
240	8/16/2024	NGO-EPN	General Opposition	In 2008, EPA issued a Final Determination under Section 404(c) of the CWA withdrawing the specification of the proposed project site for the discharge of dredged and/or fill material for the construction of the project. EPA determined that "the construction and operation of the proposed pumps would dramatically alter the timing, and reduce the spatial extent, depth, frequency, and duration of time that wetlands within the project area are inundated." Furthermore, "these large-scale hydrologic alterations would significantly 1 Final Determination of the U.S. Environmental Protection Agency's Assistant Administrator for Water Pursuant to Section 404(c) of the Clean Water Act Concerning the Proposed Yazoo Backwater Area Pumps Project Issaquena County, Mississippi. August 31, 2008. https://www.epa.gov/sites/default/files/2015-05/documents/yazoo-final-determination_signed_8-31-08.pdf degrade the critical ecological functions provided by approximately 67,000 acres of wetlands in the Yazoo Backwater Area, including those functions that support wildlife and fisheries resources."2 These impacts were not tied to the particular footprint/precise location of the proposed pump but rather to their operation and purpose. Significant portions of the area that would have been impacted are currently in national wildlife refuges, national forest lands, lands enrolled in federal conservation programs, and state-owned conservation lands. In addition, some of the lands have been purchased and restored using taxpayer funds as mitigation for previously constructed federal water projects. The implementing regulations for Section 404(c) of the CWA, 40 CFR Part 231, set out a very specific and mandatory process to issue Section 404(c) Final Determinations. During the 2008 Section 404(c) process, EPA met with local stakeholders, held a formal public hearing, issued and published draft and recommended determinations that allowed for public comment, and responded to all comments made and/or submitted related to the project. This process allowed for a full vetting of all the relevant issues, including the environmental impacts of the project as well as environmental justice concerns. The scope of the 2008 EPA Section 404(c) review included all the alternatives presented by ACOE in the National Environmental Policy Act (NEPA) documents that supported the project, including Plans 3, 4, 5, 6, 7, and a modified Plan 6. During its review and in the Final Determination, EPA found all six of the plans resulted in unacceptable adverse effects to wetlands and fish and wildlife resources (including spawning and breeding areas), the trigger for action under Section 404(c). Ultimately, in 2008, ACOE chose Plan 5 as the Least Environmentally Damaging Practicable Alternative (LEPDA), which became the subject of the Section 404(c) Final Determination. On January 15, 2021, ACOE published its Record of Decision (ROD) for the Yazoo Area Pumps Project. The ROD was based on the Final Supplemental EIS No. 2, which was finalized on December 11, 2020, with a 45-day public comment period. On November 30, 2020, the then Regional Administrator for EPA Region 4 concluded that the proposed project was not prohibited by EPA's 2008 Final Determination.3 This conclusion was challenged in court and resulted in a remand from the court back to EPA for reconsideration. EPN submitted comments4 on October 15, 2021, noting that EPN believed the Regional Administrator at that time erroneously concluded that the proposed 2020-21 pump project was not covered by the 2008 Final Determination. The decision had been made without the opportunity for public input and importantly did not follow precedent for modifying a CWA Section 404(c) Final Determination. As a result, many of the issues the public commented on and the EPA reviewed as part of the 2008 Final 4 https://www.environmentalprotectionnetwork.org/wp-content/uploads/2021/10/EPN-Letter-on-Yazoo-404c-permit.pdf 3 November 30, 2020 letter from Mary S. Walker, Regional Administrator, EPA Region 4, to Colonel Robert A. Hilliard, U.S. Army Corps of Engineers, Vicksburg District. 2 Final Determination of the U.S. Environmental Protection Agency's Assistant Administrator for Water Pursuant to Section 404(c) of the Clean Water Act Concerning the Proposed Yazoo Backwater Area Pumps Project Issaquena County, Mississippi. August 31, 2008. page i. 2 Determination, including an analysis of the environmental justice issues, were not fully discussed nor was there full opportunity for public input on this highly significant federal action. Subsequently, on November 17, 2021, EPA issued a letter to ACOE, finding that the 2020-21 proposed plan was prohibited by the 2008 Section 404(c) Determination. This led to numerous discussions among the agencies and on January 9, 2023, EPA and ACOE signed a joint collaboration memorandum to work towards identifying an approach to reduce flood risk in the Yazoo Backwater Area.5Following the collaborative process, on June 28, 2024, ACOE issued a Draft EIS identifying a "new" pumping project with a 45-day public comment period initially ending on August 12, 2024, but extended to August 27, 2024. Although this plan does include some "mandatory buy-outs"of 52 homes in economically-disadvantaged communities in the Yazoo Backwater Area, it also includes a substantial pump that has the potential to drain the same or similar wetlands identified in the 2008 Section 404(c) Determination and potentially more. EPN believes that, similar to our earlier position on the 2020 version of the project, this proposed project would not be allowed under the 2008 Final Determination unless that Determination is modified following practices EPA had established in prior actions. It is important to note that the 2008 Final Determination anticipated and prohibited any similar pump projects located within the Yazoo Backwater Area identified in the Final Determination that would have the same or similar adverse impacts within the project area. Simply moving the location of the pumps upstream within the same defined project area, changing the fuel used by the pumps, changing the size of the pumps, or changing pump operation parameters does not significantly alter the project impacts or its purpose. In the 2008 Final Determination, EPA noted that "derivatives of the prohibited projects that involve only small modifications to the operational features or location of these proposals would also likely result in unacceptable adverse effects and would generate a similar level of concern and review by EPA."6 This language indicated that "derivatives" and "changes in location" were presumptively covered by the Final Determination, because of the likelihood they would have similar impacts, but that EPA would review such impacts if such changes were proposed	EPA implements CWA section 404(c) and issued the 2008 section 404(c) Final Determination concerning the Yazoo Backwater Area Pumps Project. USACE therefore cannot speak to the applicability of EPA's Final Determination. See response to comment 5.
241	8/16/2024	NGO-EPN	NEPA	In order to modify the project, we believe ACOE should seek modification of the 2008 Final Determination issued by EPA. In an August 22, 2019 letter from the Regional Administrator to ACOE, EPA informed ACOE in writing about the detailed information ACOE would need to submit to EPA along with a formal request before the agency would review the 2008 Final Determination.7 Section 404(c) and the implementing regulations in 40 CFR Part 231 specifically note that a Final Determination issued by the EPA Administrator under Section 404(c) is a final agency action that is then	EPA implements CWA section 404(c) and issued the 2008 section 404(c) Final Determination concerning the Yazoo Backwater Area Pumps Project. USACE therefore cannot speak to the applicability of EPA's Final Determination. See response to comment 5.
242	8/16/2024	NGO-EPN	NEPA	subject to review in the courts. Absent court review, the path for ACOE to take to modify the project is to use the applicable Section 404(c) procedures. During the history of the Section 404(c) program, EPA has issued 14 Final Determinations. EPA has directly modified only two of the issued Final Determinations to address changed circumstances or different needs. In both cases, EPA went through the appropriate public process identified in the implementing regulations, after a specific detailed request from ACOE to modify the Section 404(c) Final Determination. This included the issuance of a public notice, the review and response to public comments, and the issuance of an amendment to the Final Determination. In both prior cases, the project changes and impacts were minor. However, although the 2020-21 Yazoo Pump project changes from the 2008 project were relatively minor, the overall project impacts are still major. The same applies to the 2024 proposed plan. By not following this process we believe EPA and ACOE did not fully consider the complex set of concerns voiced by stakeholders directly and indirectly affected by the project, including serious environmental justice concerns. Conclusion EPN believes that the 2008 Final Determination clearly prohibits discharges for the purpose of construction and operation of the proposed pump "or any similar pump project" within the defined project area that would result in similar or adverse impacts to jurisdictional wetlands and other waters of the United States. Similar to concerns EPA identified in the 2008 Final Determination and EPN expressed on earlier versions of the pumping project, EPN's concerns with the potential adverse impacts of this version of the project remain. However, if ACOE remains committed to moving forward with this version of the project, the ACOE should follow the long-standing approach to modify a CWA Section 404(c) final agency action by making a formal request to EPA. As noted above, EPA previously outlined the necessary information that should be submitted.8 This letter was prepared by EPA alumni and EPN volunteers Philip Mancusi-Ungaro and James Giattina.If you have any questions or if we can provide any further information, please contact us.	EPA implements CWA section 404(c) and issued the 2008 section 404(c) Final Determination concerning the Yazoo Backwater Area Pumps Project. USACE therefore cannot speak to the applicability of EPA's Final Determination. See response to comment 5.
243	8/21/2024	General Public	General Support	Thank you for your continued support on addressing the Yazoo backwater area pumping station. It did not take me long to know that alternative too is the best option we were given to choose from we live in the Eagle Lake community since 1942. We have confidently invested our lives into our home and properties, we knew Congress authorize the MRNT Levi with pumping stations in the 1941 congressional order we built our to code and steal it floods our property for months in 2000 1980 years ago. It was authorized is not finished until the last pump is built, may is the 93 level when the pumps would turn on we are at the bottom of the bathtub. We're hundred of thousands of water drains here making the rain water raspberry fast , the pumps need to turn on before the 93 foot elevation to ensure Eagle Lake will not flood further destroying our property on the Lakeside and our peers. We were confident our government we complete the project yet here we are 80 years later and we have seen continued flooding. I'm majority of the last few years , we are homeowners and we have lost $250,000 worth of our property in the last flood. The farmers have it worse and the wildlife and trees are dying. People are dying if the water is managed per alternative too that was certainly help if you were able to adjust the water level and dates as needed to protect the Yazoo backwater area , because we can never predict whether events that would be best for all the main alternative to with the option to adjust when the pumps are turned on and went to lower the water rainwater levels. This will be proactive measure to prevent damaged our communities and structure wildlife and our farmers to plant , when Louisiana has to optimize their crops this is why the USA started an injustice stagnant mass over septic systems degrading the environment, and causing health issues and un-American is an American is human and environmental and justice sincerely	See response to comments 1, 39, 45, and 90

Comment Number	Comment Date	Org.	Theme	Comment	Response
244	8/23/2024	MS Levee Board	General Support	! We prefer Alternative 2 with a 25,000 cfs Pumping Plant that turns on at 90' starting March 16th each year. Both Alternatives 2 and 3 will protect people, homes, roads, farms, infrastructure, wildlife, fish, trees and the environment. The Federal Family of the Corps, EPA and USFWS have worked together to develop this brand new project for the South Delta. This project is compliant with the Clean Water Act and meets the needs of the community.	See response to comments 1, 45, 67, 90, 91, 113, and 503
245	8/23/2024	MS Levee Board	Alternatives	Alternative 1 is no action, do nothing, in other words keep letting the area flood. This Alternative 1 has absolutely no support! We have been living with the "do nothing" plan for 83 years and we have seen the devastation to the economy, infrastructure, homes, lives, crops, wildlife, trees and the environment. Alternative 1 is not an option!	Comment noted. Alternative 3 has been selected as the recommended plan.
246	8/23/2024	MS Levee Board	Alternatives	Alternative 4 is the nonstructural only plan. This Alternative 4 has no local support. Another problem with this Alternative 4 is that is only takes care of structures and land that was flooded in 2019. In 2019 the backwater reached 98.2'. This is the 35-year flood. The 100-year flood is 100.5'. At a minimum this Alternative 4 should take care of all the structures and land in the 100-year flood - not a 35-year flood. The major objection to Alternative 4 or any other fully nonstructural plan is that it does nothing to protect the wildlife, trees and environment. These resources will continue to die and the eco-system will further decline with a nonstructural alternative. There are several national environmental groups that have historically opposed the project and have created a "click and send" form letter email that goes directly to the Corps. They use a short introduction overview full of misleading information to incite their members and they encourage them to "click and send" these emails to oppose the pumps and support the nonstructural Alternative 4. They will send tens of thousands of mass emails to the Corps. Please note that these emails will come from all over the United States and that these people do not know the facts and they have no idea where the Yazoo Backwater Area is located. Please dismiss these emails as a mass campaign to sabotage the Pumps. Alternative 4 is not an option!	See response to comments 1 and 229
247	8/23/2024	MS Levee Board	General Support	During the Virtual Public Meeting held July 16th there were 10 comments in the chat box - all 10 supported the 25,000 cfs pump and all 10 specifically wanted Alternative 2. During the Public Meetings held in Rolling Fork, MS on July 22nd there were 35 people who made statements. All 35 supported the pump and 24 specifically wanted Alternative 2. During the Public Meetings held in Vicksburg, MS on July 23rd there were 34 people who made statements. All 34 supported the pump and 28 specifically wanted Alternative 2. When you total up all these statements you had 79 people who made statements. All 79 supported the pump and 62 specifically wanted Alternative 2. During the virtual meeting and all the public meetings the support for the 25,000 cfs Pump was unanimous! The local community wants the 25,000 cfs pump that will protect to 90' during the crop season and 93' during the non-crop season. Alternative 2 and Alternative 3 are the only options! We prefer the earlier turn-on date of March 16th because we have an agricultural-based economy here in the Mississippi South Delta. Even if you are not a farmer, a lot of jobs and businesses in this area depend on farming to make a living. But we also understand that in the past 46 years the pumps would have only cut on before March 25th 6 times to maintain 90' (1994, 1997, 2016, 2018, 2019 & 2020). That averages to be only once in every 7 years. Historically, the vast majority of backwater floods reaching 90' happen in the April/May timeframe.	See response to comment 1
248	8/23/2024	MS Levee Board	Mitigation	We want the required mitigation lands to be obtained voluntarily as a reforestation easement instead of only in fee title. A few landowners might want to sell their land but the vast majority will only want an easement. I do not think the Government wants to acquire a bunch of little tracts spread out all over the place - it would be impossible to manage. Plus when the Federal Government buys property - the counties stop receiving annual taxes on it. Let the property owner keep the property and that way they can enjoy the recreational opportunities, maintain it, and still pay taxes to their respective counties.	Comment noted and relayed to our partners working the In Lieu Fee program
249	8/23/2024	MS Levee Board	Real Estate	We want to change "mandatory" acquisition of all structures (101 structures) below 90' to "voluntary" acquisition. I can't believe there is anyone living in a house below 90' - especially when we have seen 90' 22 times since 1979. Also we reached 95.2' or higher 3 years in a row in 2018, 2019 & 2020! But if there is anyone living in a house below 90' then give them an option to buy them out or let them stay and help protect them.	See response to comments 221 and 480.
250	8/23/2024	MS Levee Board	EJ	This project is an Environmental Justice project! 71% of the population is minority and 30% live below the poverty line. This project will help our minority and impoverished community.	See response to comment 1
251	8/23/2024	MS Levee Board	Pump Operations	The Steele Bayou Drainage Structure was completed in 1969 and is now 55 years old. The top of the Steele Bayou Structure curtain wall is 108.5' msl. In the next few years we will be raising the Yazoo Backwater (YBW) Levee up from 107' msl. The authorized grade for the YBW Levee is 112.8' msl. Since the Steele Bayou Structure is older than 50 years and modifications will have to be made to it when we raise the YBW Levee we request that the superstructure being built for the 25,000 cfs Pumping Plant includes a gravity flow drainage structure capable of passing 50,000 cfs and is built above 112.8' msl. We request that the Final EIS contain all the data and results of the Recommended Plan going forward. For instance, the current 100-year flood for the area is 100.5' and with the implementation of the 25,000 cfs pump it will drop the 100-year flood to 93.5'. This is very relevant data that shows the real and direct positive impacts of the Recommended Plan.	Comment noted
252	8/23/2024	MS Levee Board	Executive Summary	Most people looking at a 1,000 page EIS usually only read the Executive Summary found in the beginning of the document. We found the Draft EIS Executive Summary to be lacking. In fact, we found that the Draft EIS Conclusion (Section 9) located at the very end of the Main Report to be more helpful than the Executive Summary! Knowing that 99% of the population will only look at the Executive Summary in the Final EIS we ask that you do a good job in briefly and clearly explaining the details of the Recommended Plan. Please include the mitigation requirements and list the impacts, pertinent facts and data in this Final EIS Executive Summary.	Comment noted, Executive Summary has been revised for clarity.
253	8/23/2024	MS Levee Board	General Support	The Mississippi Levee Board appreciates this Draft EIS and we look forward to the Final EIS and the signing of the Record of Decision. This project is the result of a promise made by the Federal Government 83 years ago in 1941. Please move forward with completing the Environmental Documentation so we can start construction as soon as possible so we can Finish the Pumps!	See response to comment 1
254	8/23/2024	General Public	General Support	I have followed the Corps of Engineers' investigations and publications and meetings on the devastating flooding that continues because of lack of sufficient controls. I grew up on Highway 61N behind Deer Creek and lived with backwater flooding in the 60's and 70's, but nothing as devastating as in recent years. My childhood home was completely destroyed by the more recent floods. I am heartbroken. I have immediate family (and friends) who live at Eagle Lake (2nd generation). I have seen and photographed the damages and helped clean flooded primary homes. I implore you to install the pumps/systems to prevent the destruction of such a beautiful recreational area, as well as the lives of those who live there all other farms and families affected by this flooding. I am in favor of Alternative 2. Thank you for the opportunity to comment.	See response to comments 1, 39, and 91
255	8/23/2024	General Public	General Support	I was directly impacted by the flooding in the south delta. Please fix the pumps.	See response to comment 1
256	8/24/2024	General Public	General Support	Finish what was started long time ago. Other states have pumps	See response to comment 1
257	8/24/2024	General Public	General Support	Install pumps like intended and planned when levees was built! Get the water out is the main focus! This should've never been an issue if it was executed when it was supposed to be in place! Now I feel the farmers and land owners should be compensated their losses for the governments neglect!	See response to comment 1
258	8/24/2024	General Public	General Opposition	Delay Delay Delay!	See response to comment 5

Comment Number	Comment Date	Org.	Theme	Comment	Response
259	8/26/2024	Ptyamid Progect-NGO	eneral Opposition and	The 56 undersigned community members, homeowners, and landowners from Sharkey and Issaquena Counties write to express our continued opposition and outrage to the U.S. Army Corps of Engineers' (Corps) latest plan for the Yazoo Backwater Area. We will not let you ignore our voices. As we have told the Corps over and over again: We want effective flood relief through nonstructural and nature-based solutions that honors and respects our underserved communities—not the false promise of the Yazoo Pumps. On top of pushing another sham version of the Yazoo Pumps onto our communities, you now propose to take our homes and property through eminent domain and condemnation under the shameful perversion of environmental justice. This is not flood relief, this is a violation of the generational struggles our Black communities have endured in rising up against abuse, poverty, and injustice. The legacy of our communities and our families will not be sacrificed to feed the desire of affluent farm owners. Time after time, we have urged you to abandon any version of the Yazoo Pumps because we know the real truth—the Pumps will not keep our communities from flooding. The Pumps are all about enriching large farm owners by helping them plant more crops on low-lying lands while our genuine needs and requests continue to be dismissed. It is an affront to the legitimate health, safety, and recovery needs of our communities that your plan to operate the Pumps is entirely driven to benefit wealthy agricultural interests. This plan is even more appalling in the face of our continued struggle to recover from the devastating 2023 tornado and the daily hardships of persistent racial and environmental injustice. Once again, we call on you to abandon this and any version of the Yazoo Pumps and to instead work with the Environmental Protection Agency, U.S. Department of Agriculture, and others to quickly implement nature-based and nonstructural solutions that can help us recover and thrive. These solutions include elevating and flood-proofing homes, businesses and roads protecting targeted areas with floodplain easements; and engaging with Yazoo backwater farm owners to expand conservation easements and related wetland restoration, which would provide additional flood protection for our communities. Targeted, voluntary relocations and buy-outs should also be pursued if willing community members can be given enough money to allow them to relocate to areas that will be flood free. We call on you to begin to address the substantial needs of our low-income, minority communities by investing the hundreds of millions of our tax dollars needed to build the phony Pumps into these vital programs. Our communities deserve respect, action, and compassion, not yet another false promise of being saved by the Yazoo Pumps while our homes and businesses are stripped from us.	See response to comments 5 and 480
260	8/26/2024	Ptyamid Progect-NGO	eneral Opposition and	Dear Administrator Regan and Assistant Secretary Connor, As a proud son of the Mississippi Delta, I fight every day to ensure communities across the region get the justice, equality, and resources they need and deserve—whether it's the daily struggle to make ends meet, in breaking through systemic racial injustice, or recovering from the 2023 tornado tragedy that wiped my hometown of Rolling Fork off the map. So it is with great urgency that I write to you once again to call out your agencies' unacceptable and offensive pursuit of the Yazoo Backwater Pumps, a project that is a slap in the face to Black community members of the Yazoo Backwater Area. Your agencies' deliberate decision casts aside the honest requests many other minority community members and I have made in asking you to disavow the Yazoo Pumps and put your energies into providing effective 21st-century flood relief programs and environmental justice resources, especially through nonstructural and nature-based approaches. Community members like me are not fooled by the false claims that the Yazoo Pumps are the only solution to protect us from flooding. In fact, your latest plan to operate the Pumps around planting seasons lays bare what we have known all along—that this project is little more than a corporate giveaway that helps large farm owners plant more crops on low-lying farms. Building the Pumps will spend more than a billion of our tax dollars so rich farm owners can get even richer while our communities remain vulnerable to flooding in the face of structural inequity and tornado recovery. To add further insult, your Pumps plan now shockingly proposes forced removal of Black community members' homes and property through "mandatory" acquisition under the guise of "environmental justice"—an obscene perversion that could not be further from the truth. Not only does this reprehensible proposal further reinforce that the Pumps are designed to benefit wealthy white farmers, it perpetuates the oppressive burdens my fellow Black community members, generations of my family, and I have faced and work so hard to overcome. This is eminent domain pure and simple. All of this on top of the fact that your proposal roundly ignores the repeated requests from many lowincome and minority residents from the Yazoo Backwater Area for swift help in delivering 21st-century flood mitigation programs and funding, especially through effective nonstructural and nature-based flood relief tools. My work with disadvantaged communities in the Yazoo backwater to secure nonfinancial technical assistance through the FEMA BRIC program demonstrates their desire for these effective flood relief solutions—solutions that are available and funded and could quickly be put to work to benefit peoples lives and property while helping to address many fundamental hardships. I call on you to take the Yazoo Pumps and their false promise of flood relief off the table once and for all, and to immediately work to put nonstructural and nature-based flood solutions in place that can help vulnerable Yazoo backwater communities.	See response to comments 5, 39, and 480
261	8/26/2024	General Public	General Support	As a property owner at Eagle Lake I am most definitely FOR the installation of backwater pumps. My choice would be option 2, but at this point I'll take any option. There is obviously a solution to correct the problem of backwater flooding that has been known for a very long time. The groups that oppose these pumps that will only run under clearly defined circumstances do not live or make a living in the south delta and have not personally witnessed the environmental damage during and after these flooding events. It's amazing how much of a fight it has been to finish a project to keep land that is 87' above sea level from flooding. If this was impacting New Orleans that is approximately 87' lower, there would not be a debate it would just get corrected. The residents of the south delta deserve the implementation of the backwater pumps. We shouldn't have to worry every spring that our lives will be turned upside down for months due to flooding when there is a known/proven solution to correct the problem. I appreciate the work that USACE, MS Levee Board, MS state officials, and the MS congressional delegation have done to help bring this problem to a positive resolution. Please let's get the backwater pump project completed like it was originally intended to do many years ago as part of the backwater levee project.	See response to comments 1, 45, 67, 90, 91, 113, and 503
262	8/26/2024	General Public	General Support	I was out of town and therefore unable to attend the recent meetings on the subject in person. I did, however, view the Vicksburg meetings afterward on line. I live at Eagle Lake, north of Vicksburg, and experienced first-hand the devastation of the 2019 backwater flood. A flood, by the way, that was largely not publicized nationally, in stark contrast to a flash flood, or day-long flood event which may occur in other areas of the United States. We were unable to drive to/from our house for months, forced to vacate, and then make repairs to my property that were required as a result of having approximately two feet of water around our home for several MONTHS. I am now 73 years old, and still suffer pain in both my hands that is a direct result of filling, hauling and placing thousands of sandbags in a losing effort to protect my and others' property. My career was primarily as a Project Manager in private industry for corporate capital projects, many of which were for many millions of dollars. I can safely say that if the corporation approved $X to implement a project that consisted of three necessary components, and I only completed two of them, I would have been terminated. That is basically what the Corps of Engineers has done as it pertains to the Yazoo Backwater Project. We have the levees and the control structure in place, but now, some forty-five years later, we still do not have the third required component - the pumps. The other similar flood control projects around the United States all have the three components, but not us! (As an aside, I learned in my project management training that doing nothing is not an alternative at all.) I now feel compelled to check the USCE river level predictions EVERY DAY from fear of another 2019. Thank God we haven't experienced one although 2020 was a rough year as well. We did lose several neighbors as a result of 2019. I was able to attend previous meetings here in Vicksburg and other locations such as Rolling Fork. I keep hearing " we're studying the situation", which is somewhat encouraging, but it's time to "get off the pot" as the old saying goes. I realize you are required to perform such studies, but c'mon, I want to see some physical work get started. One of the local TV stations interviewed me as we were filling sandbags one day in 2019 and asked me if I thought I would ever see the pumps. I honestly answered "no" due to my age. I don't believe I have another 16 years left. That's how long it's been since I attended my first public meeting on the subject in 2008, I believe. And I've heard that the project would not be operational for some four years if it was approved today. Bottom line is I am in favor of Alternative 2 as the only viable option, however not necessarily tied to the dates as listed nor the turn-on/off river levels. I think that some flexibility is a must.	See response to comment 1
263	7/23/2024	General Public	General Support	Areas of concern: home accessibility, housing or property impact, access to emergency services, impacts to wildlife, impacts the wetlands, envrionment, infrastructure (electricity or road accessibility), agriculture (flooding of farmland or loss of livestock), hunting or outdoor recreation.	See response to comments 1, 39, 45, 67, 90, 91, 113, and 503
264	7/23/2024	General Public	Alternatives	I'm in favor of alternative #2. Please consider the pump on date and elevation level.	See response to comment 1
265	7/23/2024	General Public	General Support	Areas of concern: home accessibility, housing or property impact, access to emergency services, impacts to wildlife, impacts the wetlands, envrionment, infrastructure (electricity or road accessibility), agriculture (flooding of farmland or loss of livestock), hunting or outdoor recreation. We are in favor of alternative #2	See response to comments 1, 39, 45, 67, 90, 91, 113, and 503
266	7/23/2024	General Public	Alternatives	We are in favor of alternative 2	See response to comment 1
267	7/23/2024	General Public	General Support	Areas of concern: home accessibility, housing or property impact, access to emergency services, impacts to wildlife, impacts the wetlands, envrionment, infrastructure (electricity or road accessibility), agriculture (flooding of farmland or loss of livestock), hunting or outdoor recreation	See response to comments 1, 39, 45, 67, 90, 91, 113, and 503
268	7/23/2024	General Public	Alternatives	I am in favor of alternative 2 I also wish you would consider tweaking the pump on date and elevation level	See response to comment 1
269	7/23/2024	General Public	General Support	Areas of concern: home accessibility, housing or property impact, access to emergency services, impacts to wildlife, impacts the wetlands, envrionment, infrastructure (electricity or road accessibility), agriculture (flooding of farmland or loss of livestock), hunting or outdoor recreation	See response to comments 1, 39, 45, 67, 90, 91, 113, and 503
270	7/23/2024	General Public	Alternatives	We're in favor of alternative #2	See response to comment 1

Comment Number	Comment Date	Org.	Theme	Comment	Response
271	7/23/2024	General Public	General Support	Areas of concern: home accessibility, housing or property impact, access to emergency services, impacts to wildlife, impacts the wetlands, envrionment, infrastructure (electricity or road accessibility), agriculture (flooding of farmland or loss of livestock), hunting or outdoor recreation	See response to comments 1, 39, 45, 67, 90, 91, 113, and 503
272	7/23/2024	General Public	Alternatives	I am in favor of alternative 2 I also wish you would consider tweaking the pump on date and elevation level	See response to comment 1
273	7/23/2024	General Public	General Support	Areas of concern: home accessibility, housing or property impact, access to emergency services, impacts to wildlife, impacts the wetlands, envrionment, infrastructure (electricity or road accessibility), agriculture (flooding of farmland or loss of livestock), hunting or outdoor recreation	See response to comments 1, 39, 45, 67, 90, 91, 113, and 503
274	7/23/2024	General Public	Alternatives	I'm a landowner and support alternative 2 with adjustments to tourn on adn dates for the pumps	See response to comment 1
275	7/23/2024	General Public	General Support	Areas of concern: home accessibility, housing or property impact, access to emergency services, impacts to wildlife, impacts the wetlands, envrionment, infrastructure (electricity or road accessibility), agriculture (flooding of farmland or loss of livestock), hunting or outdoor recreation	See response to comments 1, 39, 45, 67, 90, 91, 113, and 503
276	7/23/2024	General Public	Alternatives	I'm a landowner in the YBW area and support alternative #2 with attention to possible adjustments for pump turn on dates & turn on elevation	See response to comment 1
277	8/27/2024	General Public	General Support	Just wanted to cast my vote to help my family avoid another catatrouphic flood	See response to comment 1
278	8/27/2024	General Public	General Support	I've spoken at every meeting. This is my last opportunity to comment, no holding back. You know who we are; you've heard our stories. We're up to the 4th generation who have waited with hopes for a pump station since Congress abandoned the Eudora and Boeuf flood ways. The floodways would have reduced stages at Vicksburg during floods by 6 feet which means the 2019 Backwater Flood and others would have had little impact. The property owners in Arkansas and Louisiana would have been paid for flowage easements. The need for a pump station was obvious in the 1940's and is now. We have suffered financially, physically, and emotionally while Arkansas and Louisiana have benefitted. The project has been studied numerous times with each of the prior reports resulting with a pump station being the preferred alternative. The pump turn-on elevation has risen from 80, to 87, to 90 or 93 with each requiring larger pumping capacity. Higher costs and a tougher sell to Congress. While the wildlife, forests, property owners, and inhabitants have suffered, your report increases costs by claiming that the pump options will require mitigation for fish – when the backwater area exceeds the combined acreage of Mississippi's 5 largest reservoirs, mitigation for duck usage – when the report acknowledges that dabbler ducks only feed in water 2 feet deep or less, mitigation for wetlands – when prolonged flooding during 2019 killed a large percentage of the hardwoods in the wetlands of the lower areas of the basin, killed 70% of the wildlife with almost no birds nesting. After the devastation of the 2019 Flood, all credible foresters, wildlife biologists, ornithologists, and economists support a pump station. A no-pump decision can only be based on greed – political payments from the elite whose goal is to force the reforestation of 200,000 acres of the most productive farmland. This during a time of worldwide food insecurity. These same elitists have corrupted the Sierra Club and the Audubon Society into opposing a project that actually supports their mission statements. Research NCX, the Bill Gates backed carbon credit company that seeded the carbon market with one-year contracts in 2022. After the demonstrated devastation to the flora and fauna during the 2019 Flood, a no-pump decision will totally discredit the EPA. It will fully reveal that EPA has been bought and the pump issue is politically corrupt instead of based on science. It will result in a lawsuit of damages. The damages will be what we have endured compared to the benefits that Arkansas and Louisiana have enjoyed. Each team member producing this report should be deposed to explain how they chose a no-pump alternative when a fourth grader can explain what happened if they put a potted plant and a hamster in a bathtub full of water. Each of your team's members knows the right decision. You must look into the mirror of your personal integrity; who will you see? Or have you been bought like the Sierra Club and Audobon? I truly hope that my negative comments were misguided. If so, my appologies. I join the vast majority of the South Delta in supporting Alternative 2.	See response to comments 1, 45, 67, 90, 91, 113, and 503
279	8/27/2024	General Public	General Support	Option 2 is the only workable, moral and fair option for everyone. I have lived in this area for many years. First on hwy 465 where my family suffered five floods from the Mississippi and Yazoo rivers. These were short and workable. Then the federal flood control came. It came with many of the other options mentioned now. They talked about buying us out but never did. They used the 50% rule to force us out. I was left with a 40,000 mortgage that I paid off with my last flood insurance check. Between the government and the (county which devalued my home) from 70,000 to 40,000 I was left with nothing. Just a loan to start over. What we are looking at now with backwater flooding is whole different animal. I built at Eagle Lake on high ground so as to never to see another flood but here we are. Now they are raising the flood level to build. Now I am a few inches out of compliance. Here comes the 50% rule and talk of buyouts and relocating families. If backwater flooding is fixable with option 2, then no more discussion is needed. It is time to protect families, wildlife and property.	See response to comments 1, 39, 45, 67, 90, 91, 113, and 503
280	8/27/2024	General Public	General Support	Dear Sirs, I have family and friends that have lived through numerous, preventable flood events over the last 30 years in the Yazoo Backwater Area. They have waited while flood after flood destroyed their lives, business, farms, property, homes and not least the impact it has had on the environment. In 2019/2020 over half of the deer population was starved to death. Terrestrial animals drown or were eaten by their own kind. I pray those opposing the pumping plant have been given the facts of what the flooding has done to the wetlands, the birds, the trees, the human injustice. I don't know why their opinion should even matter if they have not seen it with their own eyes. The people that have lived it for decades should be the ones heard. Most are only voting because they are told to. Lied to. Listen to us. We are the victims of a project that was walked away from, leaving us in a flood zone that was man made. There is no way around this but to install a pumping plant of any kind to keep the rainwater from filling up the backwater area and rotting it away. Alternative two is the preferred solution out of the four choices we were given by the three major leaders making this decision. Why do you need anyone opposed to this to tell you what to do?This is pure torture to the lower delta. pumping plant is the only solution. The Corps, EPA, etc.. have bounced solutions back and forth for years. You are working together now. WHY do you need groups to tell you THE GOVERNMENT what to do. They have an agenda of making money from donations. This is how they make money. They are using this to make millions. Anyone with any sense can see this is destroying everything they pretend to care for. WE are the stewards, not them. Listen to the victims. You promised to protect us, do it.	See response to comments 1, 45, 67, 90, 91, 113, and 503
281	8/27/2024	General Public	General Support	I SUPPORT OPTION TWO	See response to comment 1
282	8/27/2024	General Public	General Support	We need these pumps! You caused this problem by starting the backwater structure and now you need to finish it. We support option 2. Let's get it done. Thank You.	See response to comment 1
283	8/27/2024	General Public	General Support	We need these pumps! You caused this problem by starting the backwater structure and now you need to finish it. We support option 2. Let's get it done. Thank You.	See response to comment 1
284	8/27/2024	General Public	General Support	As a survivor of the 2019 Backwater Flood I support option 2 to prevent another devastating flood. The preventable 2019 Backwater flood is still taking an emotional and mental toll on me. Flashbacks occur often of the starving animals I saw. I cried many times for the slow death those animals incurred. I witnessed the loss of a tree in our backyard where eagles landed. That day was horrible as the flood water uprooted the habitat for our national bird. Six years later and the memories are vibrantly etched in my mind. Please help the people of Eagle Lake and the Mississippi Delta. Begin option 2 immediately.	See response to comments 1, 39, 45, 67, 90, 91, 113, and 503
285	8/27/2024	General Public	General Support	I have owned land in the backwater area for most of my life. My family has been here for over 80 years. Currently I live at Eagke Lake. I run one buisness from there as well operate another in valley park. In the last 10 years the losses I have encountered have been devastating to my family, both emotionally and financially. First It depleted our savings and now the loans, along with the extreme inflation, are driving me further in debt. This man made problem has changed my life as well as my children's. We struggle to pay for higher education that would have been taken care of with savings exhausted. Simply put I have nowhere to go an our livelihood depends on your decisions. Thank you for considering our support!	See response to comment 1
286	8/27/2024	General Public	General Support	FINISH THE PUMPS	See response to comment 1
287	8/27/2024	General Public	General Support	I support option 2.	See response to comment 1

Comment Number	Comment Date	Org.	Theme	Comment	Response
288	8/27/2024	General Public	General Support	As a resident of Mississippi (or former resident) I'm writing to support Option 2 with the completion of the pumps that were included in the original flood contro plan from 1941. The early start date for initiating pumping offers the best scenario for local agriculture, wildlife and quality of life for delta residents. A flood control plan that was implemented to protect the state from river flooding should not endanger the state due to trapped water behind the incomplete structures. The 2019 prolonged flood and devastation to our state should not be allowed to happen again. I was born and raised in Mississippi and though not a resident of the MS delta, have direct knowledge of the impact and damage our state suffered during the prolonged backwater flood of 2019. I have family that lives in that area and watched the physical, mental and financial suffering that they endured because the pumps were not installed as designed. Please finish this project as designed. I support Option 2 as the best alternative for the MS delta and our entire states economy. As a Mississippi resident I do not understand why flood control projects were completed in every other state but ours. Those states did not suffer the devastation that occurred here in 2019 or threatened in 2020. The installation of pumps and earliest starting date for pumping are imperative for the survival of the Mississippi Delta. Option 2 is the best solution to protect the MS Delta's infrastructure, wildlife, agriculture, work force, access for emergency services, medical care and quality of life for residents - and to insure that this prolonged man made tragedy does not occur again. A giant bathtub was created in the Mississippi Delta with the implementation of the 1941 flood management plan without the completion of an emergency overflow. I'm glad to see that the EPA and the USACE are working together to remedy and prevent future backwater flooding. Option 1, doing nothing, and buy outs are not the answer. The answer is finish the pumps! Option 2 in my opinion provides the best timeline for farmers and residents to negate the impact of spring flooding and prevent the 6 months of devastating flooding of 2019 from happening again. My family suffered physically, emotionally and financially from the prolonged flooding that occurred due to the lack of pumps and incompletion of the Yazoo Backwater Project. I'm writing to support Option 2 as the best solution provided by the EPA and USACE in preventing this disaster from happening again. The devastation from backwater flooding in 2019 should not have occurred and should be prevented from happening again. The damage to the environment, wildlif and infrastructure can still be seen today. My family suffered physically, emotionally and financially from the prolonged flooding that occurred due to the lack of pumps and incompletion of the Yazoo Backwater Project. I support Option 2 as the best solution provided by the EPA and USACE to save the Mississippi Delta and our states economy.	See response to comments 1, 45, 67, 90, 91, 113, and 503
289	8/27/2024	General Public	General Support	Please accept this email as my support for the completion of the Yazoo Backwater Pump project in Mississippi. Please provide all financial support necessary to complete the project as promises possible. The natural resources and the communities of the vicinity are in desperate need of help to help reduce the exaggerated flooding conditions that are destroying our forests, wildlife habitats, agriculture, and economy of the area.	See response to comments 1, 8, 45, 67, 90, 91, 113, and 503
290	8/27/2024	General Public	General Support	My husband and I lived through the Back Water Flood of 2019. We have a home on Eagle Lake Shore Road which is close to where the back water broke through the sand bags that Eagle Lake residents had laboriously placed for miles along the side of the road to keep the back water from entering Eagle Lake and equalizing. When the back water broke through after a storm blew away some of the sand bags, the water crossed the road and we essentially had a water fall that washed out the neighbor's 100 foot lot. During this flood fight, Eagle Lake residents and others struggled to fill sand bags to keep our homes from flooding. We fought valiantly but lost the fight in May when the back water and the lake equalized at an elevation of about 98.2 feet. This flooded many of our roads. We were told to evacuate. Where were we supposed to go? Our homes were inaccessible. FEMA finally did give us a pittance for housing but not enough to cover our costs for housing during the 3 month period that we were not able to get back home. It was a horrible, stressful time in our lives made worse by the knowledge that this could have been prevented years ago if promises had been kept by our government. It is hard for us to believe that our fight to get the pumps installed to keep our homes from flooding from this man made situation is still being studied and delayed ad nauseam! It is also hard to believe that this project was completed up until the pump installation. This means that the back water flooding was made worse for our area when the project funneled all of the back water from Memphis, south through Steele Bayou where it can't go anywhere if the river is too high and the locks have to be closed. The final step to this project was to build the pumps which is yet to be done due to ridiculous claims made by Environmental Groups who don't have a clue. They do not live here. This is not their home. We are hoping that no more studies will be done. It is time to right the wrong that has impacted our homes and our community. This could be a beautiful, economically vibrant community if the pumps were built. Do the right thing and keep your promises. We are the only back water community who do not have pumps. Is this right? Is this fair to our community? We have seen the devastation and lived it. We have seen the animals dying of starvation and drowning. We have seen the beautiful trees falling over and dying, even to this day because their roots were covered in water for so long. How can this flooding be considered good for the environment? Alternative 2 is the only viable option.	See response to comments 1, 45, 67, 90, 91, 113, and 503
291	8/27/2024	General Public	General Support	We support option #2	See response to comment 1
292	8/27/2024	General Public	General Support	The pumps are much needed in the Mississippi Delta. The 7 months of flooding in 2019 destroyed my mobil home and numerous trees. This project is entirely overdue!!	See response to comment 1
293	8/27/2024	General Public	General Support	Good afternoon. I will resubmit my original letter from one of the many comment periods in the past. I am a landowner in Onward, MS and operate 3 businesses in the flood zone and approximately 15 miles north of the proposed pump site. My grandfather cleared our land in 1947 and we have lived, farmed, hunted, and improved those 1450=/- acres now for the last 76 years. My grandfather built and operated the first country grain elevator in Mississippi for many years on the corner of Highway 61 and Blanton Road. We have a long history there and I have managed the land ever since his passing 35 years ago. In 1998 I created another company called South Delta Hunting Club, Inc. in which I lease our homes and land out to hunters on an annual basis. In 2015 I formed another company, Delta Precision Shooting, LLC, which teaches marksmanship to both civilians and military personnel. All 3 companies operate in the Yazoo Backwater zone, and it has been extremely difficult. My property ranges from 84-100' elevation and we deal with varying levels of flooding nearly every year. Like most landowners, I have already turned the land below 87' into bottomland hardwood conservation easements such as CRP or WRP and the remaining land is still farmland. When the backwater rises above 87', my hunting business suffers while the deer and other animals are forced out of their habitat, the duck's food is too far below the surface of the water for them to eat, my farmland floods which decreases its productivity and value, and the shooting range is flooded which closes the school. In 2019 I suffered approximately $300,000.00 in lost revenue from this preventable, man-made catastrophe and received a compensation check for $12 (twelve) dollars from the USDA in return. Thank you for coming together with multiple other groups and finally pushing this project forward after its initial authorization 82 years ago. Please consider lowering the pumping elevation to 87' and widen the planting window... not to eliminate - but to reduce agricultural losses to a reasonable level. Wildlife and plants will still suffer even at that level, but I know that trying to lower it below 87' will not be politically feasible due to outside interests. This project is desperately needed and has my full support. I will be more than happy to provide you with more information should you request it.	See response to comments 1, 45, 67, 90, 91, 113, and 503
294	8/27/2024	General Public	General Support	My name is Marty Hendrix and was a resident at Eagle Lake during the prolonged flood event during 2019 and again suffered property damage during the flooding in 2020. I support option two.	See response to comment 1
295	8/27/2024	General Public	General Support	I support the proposition !	See response to comment 1
296	8/27/2024	General Public	General Support	To whom it may concern, I grew up in Vicksburg, experienced the '73 flood as a young college kid, worked for the District in Hydraulics Branch and Regulatory Branch from '82-'96, was involved in every flood fight during that period of time. I've seen the damage, mayhem caused by these catastrophic events. I fully support Alternative #2 and encourage USACE to implement.	See response to comment 1
297	8/27/2024	General Public	General Support	This email in support of Option 2 for the Yazoo Backwater Project. My family and I lost 3 homes to the Backwater Flood at Eagle Lake. The pier is still damaged due to the money lost and we refuse to complete it until the pumps are in. We lost not only our homes, but trees were destroyed and continue to fall during storms due to the damage sustained. Not to mention the wildlife lost. Please finish the pumps!!	See response to comments 1, 39, 45, 67, 90, 91, 113, and 503
298	8/27/2024	General Public	General Support	I support Alternative 2 on the Yazoo Backwater pumps. It needs to happen now!	See response to comment 1
299	8/27/2024	General Public	General Support	I support the pumps. Option two. Thank you.	See response to comment 1
300	8/27/2024	General Public	General Support	The pumps are much needed in the Mississippi Delta. I support option 2. The 7 months of flooding in 2019 destroyed my mobil home and numerous trees. This project is entirely overdue!!	See response to comments 1 and 39
301	8/27/2024	General Public	General Support	We support option number two. We have went Way beyond enough now please get this done.	See response to comment 1

Comment Number	Comment Date	Org.	Theme	Comment	Response
302	8/27/2024	General Public	General Support	It's 2024 and I can still see the damage incurred driving to and from my home at Eagle Lake from the prolonged flooding that occurred in 2019. More and more hardwood trees fall across highway 465 with each light storm. By my amateur count of animals that I see on my route, the wildlife have not fully returned to the area. I still see empty homes and multiple broken piers and docks on the lake from people too mentally or financially exhausted to rebuild. Multiple cypress trees in the middle of the lake that provided animal habitat and shade for boaters are dead from being underwater for so long. Our highway and county roads still bea scars with sunken areas, narrow dangerous shoulders, pot holes and poor striping. We are the only state with a flood project like this that is left uncompleted. We need an overflow system or drain for this giant bathtub that was created, we need the pumps installed and the project completed. I appreciate the joint work of the EPA and the USACE and hope that installation of the pumps will begin as soon as possible. I support Option 2 as the best solution based on the four options provided. Whether these dates and levels are the best is still debatable. I believe that the USACE should have more flexibility in managing activation times and water levels based on situation, science and expertise.	See response to comments 1, 45, 67, 90, 91, 113, and 503
303	8/27/2024	General Public	General Support	This is my second email in support of Option 2 from the options provided to us by the EPA and the USACE, my first was in July. I hope my two emails carry more weight than the approximate 100,000 form letter emails vomited out by the lemmings following each other over the cliff driven by environmental groups with no factual information or knowledge about what they are responding to. I hope engineering and science carry more weight than emotions and volume of emails. I hope the studies done by MSU, MEMA, MSEMA, the EPA, the USACE and other agencies have proven that the flood project should be completed and the pumps should be installed. I hope that the USACE will have more flexibility i the operation of water levels and activation times based on current situations, weather and climate conditions and environmental impact rather than hard dates or levels. I continue to support Option 2,	See response to comments 1, 45, 67, 90, 91, 113, and 503
304	8/27/2024	General Public	General Support	Hello, my name is Rob Neblett. I own approximately 1000 acres along the banks of Steele bayou 2 1/2 miles north of the lock. I cannot emphasize the importance of getting this project finished. It would help prevent devastating floods that have completely wiped out the wildlife and damaged thousands of acres of crop land. No one would even believe the bones that I witnessed piled up for miles after the 19 flood. It will be many years before several species recover. Seasonal floods are understandable but the locks would at least prevent the catastrophic flooding that took place those two years if a pump system was allowed in place. I hope whoever is in charge will consider the thoughts and opinions of those that have actually seen it and lived it not just read it from 1000 miles away. Thank you for your consideration.	See response to comments 1, 45, 67, 90, 91, 113, and 503
305	8/27/2024	General Public	General Support	I have seen the devastation!! The destruction! Homes and businesses totally destroyed! Dead animals floating in many feet of water. Death, disease, destruction! It is WAY past time to get these pumps installed and running!	See response to comments 1, 39, 45, 67, 90, 91, 113, and 503
306	8/27/2024	General Public	General Support	I support alternative 2. Coming from a girl that has lived her entire life in the delta and now hopefully so will our 3 children- I am in strong support of the pumps to put in place. The devastation we witnessed in 2019 and what we lived through will forever be in my mind and on my heart to continue to pursue the right thing to do for not only our communities, but our wildlife.	See response to comments 1, 39, 45, 67, 90, 91, 113, and 503
307	8/27/2024	General Public	General Support	Lived in the lower Mississippi delta region for 8 years. Adamantly support option 2 for the pumps.	See response to comment 1
308	8/27/2024	General Public	General Support	Please complete the pump system for the betterment of the residents, agriculture and wildlife of the Mississippi Delta Region.	See response to comment 1
309	8/27/2024	General Public	General Support	To whom it may concern: As a former resident of Mississippi, I'm writing to support Option 2 with the completion of the pumps that were included in the original flood control plan from 1941. The early start date for initiating pumping offers the best scenario for local agriculture, wildlife and quality of life for delta residents. A flood control plan that was implemented to protect the state from river flooding should not endanger the state due to trapped water behind the incomplete structures. The 2019 prolonged flood and devastation to our state should not be allowed to happen again. I was born and raised in Mississippi Delta and though not a resident of the MS delta now, have direct knowledge of the impact and damage our state suffered during the prolonged backwater flood of 2019. I have family that live in that area and watched the physical, mental and financial suffering that they endured because the pumps were not installed as designed. Please finish this project as designed. I support Option 2 as the best alternative for the MS delta and our entire states economy.	See response to comments 1, 39, 45, 67, 90, 91, 113, and 503
310	8/27/2024	General Public	General Support	As a resident of Mississippi (or former resident) I'm writing to support Option 2 with the completion of the pumps that were included in the original flood contro plan from 1941. The early start date for initiating pumping offers the best scenario for local agriculture, wildlife and quality of life for delta residents. A flood control plan that was implemented to protect the state from river flooding should not endanger the state due to trapped water behind the incomplete structures. The 2019 prolonged flood and devastation to our state should not be allowed to happen again. I was born and raised in Mississippi and though not a resident of the MS delta, have direct knowledge of the impact and damage our state suffered during the prolonged backwater flood of 2019. I have family that live in that area and watched the physical, mental and financial suffering that they endured because the pumps were not installed as designed. Please finish this project as designed. I support Option 2 as the best alternative for the MS delta and our entire states economy. As a Mississippi resident I do not understand why flood control projects were completed in every other state but ours. Those states did not suffer the devastation that occurred here in 2019 or threatened in 2020. The installation of pumps and earliest starting date for pumping are imperative for the survival of the Mississippi Delta. Option 2 is the best solution to protect the MS Delta's infrastructure, wildlife, agriculture, work force, access for emergency services, medical care and quality of life for residents - and to insure that this prolonged man made tragedy does not occur again. A giant bathtub was created in the Mississippi Delta with the implementation of the 1941 flood management plan without the completion of an emergency overflow. I'm glad to see that the EPA and the USACE are working together to remedy and prevent future backwater flooding. Option 1, doing nothing, and buy outs are not the answer. The answer is finish the pumps! Option 2 in my opinion provides the best timeline for farmers and residents to negate the impact of spring flooding and prevent the 6 months of devastating flooding of 2019 from happening again. My family suffered physically, emotionally and financially from the prolonged flooding that occurred due to the lack of pumps and incompletion of the Yazoo Backwater Project. I'm writing to support Option 2 as the best solution provided by the EPA and USACE in preventing this disaster from happening again. The devastation from backwater flooding in 2019 should not have occurred and should be prevented from happening again. The damage to the environment, wildlife and infrastructure can still be seen today. My family suffered physically, emotionally and financially from the prolonged flooding that occurred due to the lack of pumps and incompletion of the Yazoo Backwater Project. I support Option 2 as the best solution provided by the EPA and USACE to save the Mississippi Delta and our states economy.	See response to comments 1, 39, 45, 67, 90, 91, 113, and 503
311	8/27/2024	General Public	General Support	I'm resident of Clinton. I work as a research engineer at ERDC. My mother, step father, brother, SIL, and 2 nephews live in the Eagle lake community. They were deeply affected by the 2019 flood, and other preventable backwater flooding disasters. Please protect our communities, our environment, and our farmers by constructing the pumps.	See response to comments 1, 39, 45, 67, 90, 91, 113, and 503
312	8/27/2024	General Public	General Support	I am sending this email to voice my support of Alternative 2 and the installation of the Yazoo Backwater Pumps. I have hunted and enjoyed the resource that is the South Delta my entire life. It is of upmost importance for us to acknowledge the devastation that was the 2019 backwater flood and its impact on infrastructure and most importantly our wildlife and hardwoods. This area is where I spent my childhood hunting and fishing with my family. It is easily seen the impact this flood had on our wildlife and long standing hardwood forests. I know of trees that are older than anyone alive that are now dead, weakened, and blown over. Deer and bird populations are still recovering today. It should be an easy decision to install any mitigation effort to protect this region, not just for me but for my children. Honestly not much is available in Mississippi as far as healthy activities aside from our great outdoors. This is in threat of being lost. Knowing that these types of pump stations are successfully in place elsewhere and are in threat of being denied in my area is a slap in the face. I have not heard any common sense reason to not install them, and I have heard all reasoning. Anyone not living in this region should not have a say in how we protect our resources. Anyone in favor of maintaining natural habitat and wildlife should be in favor of these pumps, it is plainly seen in our hardwood forests what inundation effects can have. Please for the sake of my children's future in the outdoors of my home region of Mississippi, build the pumps.	See response to comments 1, 45, 67, 90, 91, 113, and 503

Comment Number	Comment Date	Org.	Theme	Comment	Response
313	8/27/2024	General Public	General Support	Yazoo Backwater project As a resident of Mississippi I'm writing to support Option 2 with the completion of the pumps that were included in the original flood control plan from 1941. The early start date for initiating pumping offers the best scenario for local agriculture, wildlife and quality of life for delta residents. A flood control plan that was implemented to protect the state from river flooding should not endanger the state due to trapped water behind the incomplete structures. The 2019 prolonged flood and devastation to our state should not be allowed to happen again. I was born and raised in Mississippi and though not a resident of the MS delta, have direct knowledge of the impact and damage our state suffered during the prolonged backwater flood of 2019. I have friends that live in that area and watched the physical, mental and financial suffering that they endured because the pumps were not installed as designed. Please finish this project as designed. I support Option 2 as the best alternative for the MS delta and our entire states economy. As a Mississippi resident I do not understand why flood control projects were completed in every other state but ours. Those states did not suffer the devastation that occurred here in 2019 or threatened in 2020. The installation of pumps and earliest starting date for pumping are imperative for the survival of the Mississippi Delta. Option 2 is the best solution to protect the MS Delta's infrastructure, wildlife, agriculture, work force, access for emergency services, medical care and quality of life for residents - and to insure that this prolonged man made tragedy does not occur again. A giant bathtub was created in the Mississippi Delta with the implementation of the 1941 flood management plan without the completion of an emergency overflow. I'm glad to see that the EPA and the USACE are working together to remedy and prevent future backwater flooding. Option 1, doing nothing, and buy outs are not the answer. The answer is finish the pumps! Option 2 in my opinion provides the best timeline for farmers and residents to negate the impact of spring flooding and prevent the 6 months of devastating flooding of 2019 from happening again. My family suffered physically, emotionally and financially from the prolonged flooding that occurred due to the lack of pumps and incompletion of the Yazoo Backwater Project. I'm writing to support Option 2 as the best solution provided by the EPA and USACE in preventing this disaster from happening again. The devastation from backwater flooding in 2019 should not have occurred and should be prevented from happening again. The damage to the environment, wildlife and infrastructure can still be seen today. My family suffered physically, emotionally and financially from the prolonged flooding that occurred due to the lack of pumps and incompletion of the Yazoo Backwater Project. I support Option 2 as the best solution provided by the EPA and USACE to save the Mississippi Delta and our states economy.	See response to comments 1, 39, 45, 67, 90, 91, 113, and 503
314	8/27/2024	General Public	General Support	I was born and raised in Mississippi and through not a resident of the MS delta, have direct knowledge od the impact and damage our state suffered during the prolonged backwater flood of 2019. I have friends that live in the ara and watched the physical, mental, and finacial suffering that they endured because the pumps were not installed as designed. Please finish this project as designed. I support option 2 as the best alternative for the MS delta and our entire states economy	See response to comment 1
315	8/27/2024	General Public	General Support	I'm support and encourage you to proceed with option 2: Alt 2 - Construct a pump station with an earlier turn-on date	See response to comment 1
316	8/27/2024	General Public	General Support	I support alternative/plan number 2	See response to comment 1
317	8/27/2024	General Public	General Support	Please consider option 2 for helping to control the back water flooding in the Mississippi Delta . I have first hand witnessed the devastation to the land and to the animals - it was heartbreaking to pass land dwelling animals that were stranded and starving. The addition of pumps at Steele Bayou would help - I understand they will not completely stop all flooding but to help minimize the loss of wildlife and land damage.	See response to comments 1, 45, 67, 90, 91, 113, and 503
318	8/27/2024	General Public	General Support	I'm in support and encourage you to proceed with option 2: Alt 2 - Construct a pump station with an earlier turn-on date	See response to comment 1
319	8/27/2024	General Public	General Support	I support alternative 2 of the Yazoo Backwater Report. This is the most beneficial option for the people of Mississippi, the state's economy, and the wildlife that inhabits the area.	See response to comments 1, 45, 67, 90, 91, 113, and 503
320	8/27/2024	General Public	General Support	As a Mississippi resident I do not understand why flood control projects were completed in every other state but Mississippi. The states with pumps did not suffer the devastation that occurred here in 2019 or threatened in 2020. Two of the three counties affected are the two poorest counties in Mississippi. The third county, Warren County, serves as a resource for food, health care and employment. During the flood of 2019, the residents of Sharkey and Issaquena were cut off from things that have a direct impact on quality of life. These hardships won't be isolated events as the effects of global warming continue to impact our environment with extreme weather conditions. The 2019 flooding had a negative impact on the area wildlife as well. The food needed by ducks, deer, bears and other animals was under water for up to six months. Fortunately, the flooding in 2020 did not reach the levels that were experienced in 2019. It's time to stop this undue stress for God's creatures whether they are human, animals or fowl. The installation of pumps and earliest starting date for pumping are imperative for the survival of the Mississippi Delta. Option 2 is the best solution to protect the MS Delta's infrastructure, wildlife, agriculture, workforce, access for emergency services, medical care and quality of life for residents - and to ensure that this prolonged manmade tragedy does not occur again.	See response to comments 1, 45, 67, 90, 91, 113, and 503
321	8/27/2024	General Public	General Support	I support alternative 2	See response to comment 1
322	8/27/2024	General Public	General Support	I've told you all my story about living through the backwater flood for the last 5 years now. I live at onward in issaquena county. I farm, live , and hunt there. There isn't a better place to live. The people who live in this community truly love and care about one another, the animals and the environment. You absolutely will NOT find more passionate people who want to preserve this area for the future generations than the people who ACTUALLY live here. The devastation that occurred in 2019 & 2020 is absolutely inexcusable to not only the environment, animals, and the people. We appreciate all the work that has went into resolving this problem. We will settle for alternative 2 if that's the best you can do. However, as I stated in the Vicksburg meeting I think you can do better with the cut on elevation level and cut on dates. I just hope to see progress made on this project for the older generation who is constantly aging and dying. They fought this fight long before us and deserve to see justice served . 82 years is too long. Please do whatever you can to move this process of building the pumps along. I'm at the point of begging. Please consider the residents of Ms with more regard then those form letters sent from people who weren't here to witness the destruction of the flood for themselves. Let's fix this environmental injustice once and for all!	
323	8/27/2024	General Public	General Support	Alternative 2 please!	See response to comment 1
324	8/27/2024	General Public	General Support	I support Alternative 2 in your opinions in dealing with the devastating floods affecting the Delta region. Thank you.	See response to comment 1
325	8/27/2024	General Public	General Support	I helped people and had family who were devastated by the 2019 flooding. I watched whole herds of deer starve and die and trees die. It's time to finish the project that was designed and build the pumps.	See response to comments 1, 45, 67, 90, 91, 113, and 503
326	8/27/2024	General Public	General Support	I support Alternative 2, Lindsey Klaus, Warren County. Ps i sent an email earlier and have no record of it. Hope this helps	See response to comment 1
327	8/27/2024	General Public	General Support	I am a resident of the Eagle Lake Community and was a resident during the recent flood events during 2019 and 2020. I wish to voice my support for Option 2.	See response to comment 1
328	8/27/2024	General Public	General Support	Please pass Alternative 2. I watched my parents suffer. I witnessed wildlife that have yet to recover starve and die. Communities were ripped apart. The flood of 2019 did enough damage to last lifetimes. Please complete this project so that my family can continue their legacy. I support Alternative 2.	See response to comments 1, 45, 67, 90, 91, 113, and 503
329	8/27/2024	General Public	General Support	I helped families during the flood in 2019. I witnessed animals die and land wash away where homes were built. It's time to finish the project. I support alternative 2.	See response to comments 1, 39, 45, 67, 90, 91, 113, and 503

Comment Number	Comment Date	Org.	Theme	Comment	Response
330	8/27/2024	General Public	General Support	I am sixty-one years old and live in my childhood home, which my grandparents built. My grandfather purchased our farm in the late 1940s after the passage of the Flood Control Act of 1941, which assured the Yazoo Backwater Area protection from catastrophic flooding at elevations of 90' and above. All of the land he purchased is above that elevation. When the Holly Bluff cutoff was conceived, plans placed the canal right in the middle of my grandfather's fields, forcing him to give up fifty acres of his cropland. While he never relished the idea of losing land, he understood the value of good drainage to the whole MS Delta and believed it was honorable to make this sacrifice for many affected to have a better life. For that loss of land use, my grandfather was reasonably compensated. He realized he might not live to see the entire project completed but was confident his sacrifices would pay off for his children and grandchildren when the project was completed as promised. He died in 1960 at fifty-four years old. The 1973 flood severely damaged our house, but my dad still managed to plant and harvest a crop on our farm. He breathed a sigh of relief when the drainage structures and backwater levees were completed in 1978 and thought we were all home-free when the contract to build the pumps was awarded in 1986 and work began. He died in 1988 at fifty-one years old. My first grandchild was born on November 30, 2019. His great-grandfather and great-great-grandfather would be incredulous at the idea that their namesake, born almost eighty years after the passage of the 1941 Flood Control Act, might be living on their land in catastrophic flooding because this project was still not completed. I'm not sure either would ever have believed it was possible to go an entire crop year without farming a single acre of their farm, as happened in 2019. We managed to save our family home from flooding through some seriously heroic levee construction measures by my husband and sons. Living for seven months completely surrounde by stagnant water is undoubtedly no vacation. Watching your neighbors lose the flood fight one by one and wondering every morning for seven months if this i the morning you will step out of bed and into floodwater is exhausting. My middle son graduated from college six years ago and now farms with us. Upon graduation, he moved into a home near us and fixed it up as best he could without going into debt. He got married on February 8, 2019. On March 23, 2019, he and his wife came home from work to find their power had been cut off due to the placement of their electric meter near the rising water. They were forced to leave immediately but did not expect water to enter their house. Months later, their home became one of the lost causes. At this point, they were homeless and expecting a child. For the next three years, my son and his wife worked through the FEMA and insurance process on their demolished home, living temporarily in a small lakeside cabin. If I allow myself to dwell on how much this flooding situation has personally affected my immediate family, I can get quickly overwhelmed. Instead, I choose to concentrate on how to ensure the future changes for my own children and grandchildren. I realized early in 2019 that although I had lived in this area my entire life, I had never paid any attention to flood control issues, and if I wanted to understand the process, I would have to get educated. What I have learned is that organizations like the National Wildlife Federation, The Sierra Club, Healthy Gulf, the National Audubon Society, and American Rivers have amassed small fortunes by grossly distorting facts and disseminating disinformation to their members for the sole purpose of soliciting donations with no thought for the wildlife or environment they claim to protect. While this is an appalling practice that preys on their membership, I did not expect their disinformation campaigns could infect the halls of Congress. Yet, the same prevarications highlighted in their press releases and donation solicitations appear word-for-word in the Congressional Record in speeches and comments by legislators who have never set foot in the Yazoo Backwater Area. The degree to which these so-called environmental nongovernmental organizations have been allowed to lobby Congress and the EPA based on untrue information while residents of this area lose lives, homes, and livelihoods and the very environment and wildlife these organizations profess to protect are decimated should be criminal. We, who live in the Yazoo Backwater Area, appreciate USACE's investment of time and resources to ensure accurate data and facts regarding flooding in this area are available. The US Army Corps of Engineers, the US Department of Agriculture Farm Service Agency, and the Mississippi Emergency Management Agency have quantified the economic and environmental costs of backwater flooding, but 2019's flooding showed us there are significant REAL costs to residents of a seven-month flood that are not reimbursable. Mississippi State University developed a questionnaire to collect data that could be compiled to quantify the economic and social costs of this flood. The results are staggering. The average out-of-pocket expenses per respondent totaled over $42,000. The costs associated with increased commutes due to flooded highways and roads averaged approximately $185 per week per driver—almost $1,500 per month in a household with two working parents. Many of those affected will never recover financially. With each flood event, the Yazoo Backwater Area's population permanently decreases as flooded residents are forced to give up their homes, businesses, jobs, and hopes for the future. While it was easy to see the devastation to homes, cropland, wildlife, businesses, infrastructure, trees, the environment, and even fish left by the 2019 flood, what you couldn't see quite as quickly was the toll that devastation took on the heart and soul of the people of this area. It's one thing to experience a disaster in the form of a hurricane or a tornado that instantly destroys your home and business, followed by shock and recovery. It's an entirely different experience when that devastation is a seven-month slow death with no real recovery followed by a brief hiatus before the next torturous flood event begins. The constant stress and worry are almost unbearable. It is as unsustainable a lifestyle for people as is the flooded environment for the wildlife. We are reaching the point that truly nothing can survive the flooding in the Yazoo Backwater Area if the pump project is not completed. With COVID-19, the entire country experienced social distancing, business and job losses, decreased family incomes, and supply chain interruptions due to a virus that was no fault of their own. As a result, our government has authorized trillions of dollars in stimulus spending. Residents of the South Delta have dealt with these same impacts with flooding due to no fault of their own for generations. The solution was promised eighty-three years ago. Suppose we told those devastated by the economic ramifications of COVID-19 to sit tightly for eighty-three years, and perhaps we will deliver the funds promised today to your great-grandchildren? No one believes that would be an acceptable solution for COVID-19---nor is it acceptable for generations of South Delta residents who have experienced loss after loss due to man-made flooding. I am grateful for all the Corps of Engineers and the Environmental Protection Agency have done to make this project a reality. After decades of flooding and discouragement, I am heartened by your commitment to jointly finding a reasonable, working solution for the South Delta's people and wildlife. You have patiently listened to the area's residents express their frustrations and grievances and vowed to work together to ensure they do not experience another 2019-level flooding catastrophe. While we know there will be challenges to your proposal, working jointly with all relevant governmental agencies on the front end ensures your current plan is the best it can be. I cannot imagine you have another project under the entire MS River and Tributaries Project that has been as thoroughly studied as this one. Your June 2024 Draft Environmental Impact Statement and previous studies, along with unprecedented devastation from the 2019 flood, have clearly proven the pumps are the most ecological and economical solution for the communities, wetlands, aquatics, birds, wildlife, and people of the Yazoo Backwater Area. Given the proposed Water Management Plan presented in the DEIS has 2 Alternatives, Alternative 2 makes the most sense for the agriculture industry in our area. By controlling flooding in the vast area of the Delta National Forest, our area's hunting and recreational commerce will have a chance to thrive with dependable water levels and the lack of flood-induced damage to the structures and landscape in our forestry resources. Thank you for pressing forward and working with the EPA to seek a viable solution for preserving the environment of the South Delta. You are our last hope in what ha appeared to be a seriously hopeless situation for so many years. FINISH THE PUMPS!!	See response to comments 1, 39, 45, 67, 90, 91, 113, and 503
331	8/27/2024	- Taxpayers for common s	Economics	The draft EIS is currently proposing a 25,000 cfs pumping plant, which would have a pumping capacity 78% larger than the 14,000 cfs pumps prohibited by the longstanding Clean Water Act 404(c) veto of the Yazoo Pumps. Pumps of this size would likely cost federal taxpayers well over $1.4 billion.1 These pumps would be operated on a schedule driven by the desires of large agricultural producers who are farming mostly marginal lands that have always and already receive substantial federal subsidies. We believe that such a sizable investment of taxpayer money must be justified by broad public benefit, which this project clearly lacks. A point we believe your agency implicitly agrees with, as you have chosen not to undertake an updated Economic Analysis to determine what would clearly produce a low Benefit-Cost Assessment.	See response to comment 8

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332	8/27/2024	)- Taxpayers for common s	General Opposition	I write on behalf of Taxpayers for Common Sense (TCS) to express our vehement opposition to the Yazoo Pumps Project, currently under review through an updated Environmental Impact Statement (EIS). Our opposition is due to the fact this project continues to be fiscally, environmentally, and socially unacceptable for taxpayers.The potential environmental repercussions are equally troubling. A pumping plant of this size would unquestionably drain and damage 89,800 to more than 93,300 acres2 of vital wetlands, including thousands of acres that the federal taxpayers have already paid to protect. This flagrantdisregard for environmental concerns not only undermines the $100 million already invested by taxpayers in these conservation lands but also stands in contradiction to the Clean Water Act. 3We urge you to abandon the Yazoo Pumps once and for all. In its place, you should explore the many viable options for reducing flood damages through nonstructural and natural and nature-based measures, including enrolling lands in the Wetland Reserve Easement Program (WRE) and Conservation Reserve Program (CRP), which offer more cost-effective and environmentally friendly solutions to the region's flooding issues. Multiple organizations have proposed a suite of environmentally sound, equitable, and taxpayer friendly solutions that could and should be implemented. The Yazoo Pumps Project is neither fiscally responsible nor environmentally sound and raises alarming social and environmental justice concerns. For these reasons, we firmly oppose any efforts to move forward with this project and urge you to seek alternatives that are more aligned with the public interest. We appreciate the opportunity to comment on this critical issue. Should you have any questions or require further information, please feel free to contact us. Sincerely, Steve Ellis President Taxpayers for Common Sense	See response to comment 1 and 8
333	8/27/2024	NGO- Taxpayers for common sense	EJ	We are also alarmed by the social and environmental justice implications of the Yazoo Pumps Project. The potential negative impact on predominantly Black communities in North Vicksburg and other downstream locations is unacceptable. Dozens of Black community members and leaders, such as Ty Pinkins of the Pyramid Project and representatives from the Education, Economics, Environmental, Climate & Health Organization (EEECHO), have repeatedly voiced strong opposition to the Yazoo Pumps as an environmental injustice designed to serve wealthy farm owners at the expense of marginalized communities.Our analysis highlights the disproportionate benefits accruing to large agricultural producers, primarily white, who already receive significant farm subsidies. Indeed, the top 5 recipients in each YBWA zip code receive an average of $215,000 annually for the last 25 years, exacerbating economic inequalities in a region where many households earn less than $15,000 and substantial portions of the population live in poverty.	The plan, particularly the pumps, does provide Flood risk reduction to about 300 residential homes in areas of EJ concern or in majority minority or low income areas. Flood risk reduction benefits include structures no longer flooding that flooded in the 93-98.2 extent. Additionally, a voluntary buyout plan will be offerd to residential and commercial owners or, as an alternative to the voluntary buyout, dry-floodproofing for residential and commercial structures in the below 93 feet extent.
334	8/27/2024	NGO-Twin County	General Support	To Interested Parties: Twin County Electric Power Association (TCEPA) is a non-profit electric distribution cooperative headquartered in Hollandale, Mississippi, with district offices in Greenville, Belzoni, and Rolling Fork, Mississippi. TCEPA provides electric utility service to approximately 6,800 member-owners and 13,000 meters in Washington, Humphreys, Sunflower, Issaquena, and Sharkey County, MS. The 2019 Mississippi River flood was historic for its duration and record-setting water levels in the Yazoo Backwater Area. The flood caused significant economic damage to TCEPA and the communities it serves. TCEPA incurred $1.7 Million in expenses for infrastructure replacement, power restoration and loss of margins. Many residential customers were displaced from their homes, agricultural production was disrupted, and recreational businesses suffered due to habitat being forced from the area. In November 2019, TCEPA's Board of Directors adopted a resolution supporting the installation of the Yazoo Backwater Project Pumps. I am attaching a copy of the Resolution as an addendum to our letter of support. TCEPA supports Measure 2 of the Yazoo Backwater Area Water Management Project Mitigation Plan to address future habitat impacts and ecological resources. As a community stakeholder, TCEPA looks forward to continuing collaborative efforts to support the Yazoo Backwater Area Water Management Project Mitigation Plan. Sincerely, WHEREAS, Twin County Electric Power Association ("Twin County" or the "Association") serves parts of Warren, Issaquena, and Sharkey Counties in Mississippi; and WHEREAS, a significant number of Twin County's members were adversely effected by this year's backwater flood; and WHEREAS, The Flood Control Act of 1941 authorized the Yazoo Backwater Project to provide protection from higher stages on the Mississippi River resulting from the removal of the Eudora Floodway Project in Arkansas and Louisiana from the Mississippi River & Tributaries Project; and WHEREAS, the Yazoo Backwater Project authorized drainage structures, levees, and pumps to move water out of the Mississippi Delta during a high water event on the Mississippi River; and WHEREAS, the backwater areas in Arkansas and Louisiana have installed pumps; and WHEREAS, the United States Environmental Protection Agency vetoed the installation of the Yazoo Backwater Project pumps in 2008; and WHEREAS, the Yazoo Backwater Project pumps would have reduced the backwater flooding crest by over five and one-half feet, and would have reduced the area flooded by approximately 194,000 acres (including 122,000 acres of crop land), and would have prevented the flooding of homes and highways; and WHEREAS, Twin County's Board of Directors believes that the installation of the Yazoo Backwater Project Pumps is in the best interests of Twin County and its members. NOW, THEREFORE, BE IT RESOLVED that the Board of Directors of Twin County does hereby endorse the installation of the Yazoo Backwater Project Pumps as soon as possible, and encourages the United States Government to authorize and fund the installation of the Yazoo Backwater Project Pumps as soon as possible to prevent future flooding. CERTIFICATE OF SECRETARY I, Billy George Janous, the duly elected and acting Secretary of Twin County Electric Power Association, and the custodian of the minutes and other records of said Association, do hereby certify that the above and foregoing is a true and correct copy of the Resolution adopted by the Board of Directors on October 15, 2019, and that there has been no further action of the Board of Directors which would alter, amend or rescind the action taken herein. DATED: November 19, 2019	See response to comment 1
335	8/27/2024	NGO-Twin County	Economics	WHEREAS, Twin County experienced a significant loss of revenue and incurred significant additional expenses as a result of this year's backwater flood; and	Comment noted, see response to comment 1.
336	8/27/2024	NGO-Twin County	H+H	WHEREAS, the Yazoo Backwater Project pumps would have reduced the backwater flooding crest by over five and one-half feet, and would have reduced the area flooded by approximately 194,000 acres (including 122,000 acres of crop land), and would have prevented the flooding of homes and highways; and	Comment noted, see response to comments 1 and 39.
337	8/26/2024	NGO-MS Farm Bureau Federation	Alternatives	On behalf of the Mississippi Farm Bureau Federation (MFBF), I appreciate this opportunity to express our support for Alternative 2 (Crop Season 16 March - 15 October and Non-crop Season 16 October -15 March). While not perfect, MFBF believes that Alternative 2 is the best option of the four alternatives presented. Alternatives 1 and 4 are not acceptable alternatives and provide little to no protection. Our members would prefer that Crop Season dates began on March 1 and that the pumps began operation at 87'. Alternative 3 is a viable, but less desirable option. Research has shown that early-planted corn yields are higher from less insect pressure, and requires less irrigation. MFBF would like to see "voluntary" acquisition of 101 structures below 90' and would prefer that land acquisition for mitigation was done through easements rather than fee title. The land easement ,vould allo,v for mitigation, but the land would still be providing tax revenue for the county. When compared to the other Alternatives, our members believe that Alternative 2 provides the most viable option to protect homes wildlife and ecosystems.	See response to comment 1
338	8/26/2024	NGO-MS Farm Bureau Federation	General Support	MFBF is a grassroots, general agriculture organization representing over 170,000 farm family members and 17 recognized commodities. Many of our members live, ·work, or farm in Sharkey and Issaquena County and have experienced significant Yazoo Backwater flooding. The area is desperate for relief.Please consider these comments as reflecting the opinions of the people who live, work, and depend on the Yazoo Back\:vater area. We understand that there is a lot of interest from others outside of the bachvater area. They have never experienced a flood, or seen wildlife trapped and die on a levee. This problem was created by the failure to finish the MR&T project as it was designed. Nov,, is the time to rectify the problem, provide some relief to vvildlife, landowners, and citizens, and Alternative 2 is the most appropriate option.	See response to comments 1, 45, 67, 90, 91, 113, and 503

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339	8/27/2024	NGO-American Rivers	General Opposition	On behalf of our more than 350,000 members and supporters, American Rivers is writing to express our opposition to Alternatives 2 and 3 in the Draft Environmental Impact Statement for the Yazoo Backwater Area Water Management Plan . We urge the U.S. Army Corps of Engineers (Corps) to permanently abandon efforts to build any variation of the environmentally destructive, dangerous Yazoo Backwater Pumping Plant. Instead of continuing to push for this agricultural drainage project, the Corps should support deployment of highly effective non-structural, natural, and nature-based flood risk reduction solutions as also requested by many local community leaders. Since 1973, American Rivers has protected wild rivers, restored damaged rivers, and conserved clean water for people and nature. With headquarters in Washington, D.C. and 355,000 supporters, members, and volunteers across the country, we are the most trusted and influential national river conservation organization in the United States. As the nation's leading river advocate, American Rivers seeks to ensure our nation's rivers and floodplains are protected and restored. American Rivers has a long history of engaging on proposals to address flooding in the Yazoo Backwater because proposed projects that include a pumping station have consistently been found to have immense impacts to the regions' rivers and wetlands, and the people and wildlife that depend on these critically important ecosystems. These concerns have resulted in the Yazoo Backwater rivers being named one of America's Most Endangered Rivers® eight times, most recently in 2024. While we appreciate the Corps' willingness to engage in constructive dialogue with our organization regarding the most recent preferred alternative, we remain gravely concerned that any alternative that includes a pumping station will significantly degrade the ecological functions of wetlands within the project area, and that pursuing a pumping plan of this capacity violates the 2008 Clean Water Act veto, setting a dangerous precedent for reversing decisions on highly impactful water resources projects. These impacts are all the more unacceptable in light of the nation's alarming increase in wetland losses1 and the Supreme Court's 2023 decision in Sackett v. Army Corps of Engineers that has left millions of acres of wetlands without Clean Water Act protection. The concerns raised in our previous comment letters remain, including those submitted in response to the Notice of Intent on August 7, 20232 American Rivers remains concerned that local community opposition to a preferred alternative that advances a pump focused solution has not been heard. For example, during the scoping comment period, 50 community members, homeowners, and landowners from Sharkey and Issaquena Counties submitted a letter in opposition to a pump station, and voiced their preference for a whole of government approach focused on non-structural and nature-based approaches.3 Likewise, the Education, Economics, Environmental, Climate and Health Organization (EEECHO) advised the Corps the EEECHO opposes the USACE Preferred Alternative because it is "yet another appalling version of the dangerous Yazoo Pumps that will do nothing but reinforce...pervasive injustices."4. American Rivers calls on the U.S. Army Corps of Engineers (Corps) to respect the 2008 EPA veto of this project and end the effort to build a 25,000 cfs pumping station at Steele Bayou. This project is prohibited by the 2008 Clean Water Act § 404(c) Final Determination and should not be constructed. Recognizing the very real and serious flooding issues local communities face, the Corps should pursue Alternative 4, the Nonstructural Plan and should further explore opportunities to provide ongoing and sustainable benefits to the communities in the Yazoo Backwater Area while restoring this ecologically critical region.	EPA implements CWA section 404(c) and issued the 2008 section 404(c) Final Determination concerning the Yazoo Backwater Area Pumps Project. USACE therefore cannot speak to the applicability of EPA's Final Determination. See response to comment 5.
340	8/27/2024	NGO- American Rivers	Alternatives	Alternatives 2 and 3 include construction of 25,000 cfs capacity pumping stations and water management plans in violation of the 2008 Clean Water Act veto. The Section 404(c) veto authority of the Clean Water Act5 is an essential safeguard to ensure against excessive degradation of the nation's wetlands. Clean Water Act vetoes are extremely rare, with only fourteen ever issued, and is reserved for projects that will have unacceptable adverse impacts. In 2008, the Environmental Protection Agency (EPA) exercised its authority under Section 404(c) and vetoed the Yazoo Pumps on the grounds that the project would destroy tens of thousands of acres of wetlands in the heart of the Mississippi River Flyway. The 2008 Clean Water Act veto prohibits "large-scale hydrologic alterations that would significantly degrade the critical ecological functions provided by at least 28,400 to 67,000 acres of wetlands in the Yazoo Backwater Area, including those functions that support wildlife and fisheries resources." 6 The veto also prohibits a range of plans, including a 14,000 cfs pumping plant operated at 91 feet, determining that "the subsequent operation of pumping stations would result in unacceptable adverse effects on fishery areas and wildlife." The 2008 Clean Water Act veto explicitly prohibits a 14,000 cfs pumping plant with a pump-on elevation of 91-feet NGVD197 (the pumping regime for the 2007 Alternative 7).8 Alternatives 2 and 3 appear to violate this prohibition as both include a 25,000 cfs pumping plant, which is 78% larger than the plant prohibited by the 2008 Clean Water Act veto. These pumps, of course, encompass a 14,000 cfs pumping capacity: • Alternative 2 would operate a 25,000 cfs pumping plant with a pumps-on elevation at or below 90 feet for 7 months (214 days) each year during the designated crop season of March 16-October 15 and up to 93 feet during non-crop season of October 16-March 15. • Alternative 3 would operate a 25,000 cfs pumping plant with a pumps-on elevation at or below 90 feet for 6 months and 21 days (205 total days) each year, during the designated crop season of March 25- October 15 and up to 93 feet during non-crop season of October 16- March 24. Both alternatives would hold water levels below the prohibited 91-foot-NGVD elevation level for up to seven critical months each year during the designated crop seasons in an attempt to keep water levels from rising above 90-feet-NGVD. The DEIS shows that the pumps would be turned on when water levels are below 91 feet at least 82% of the time that they are used (18 out of the 22 times that the pumps would have been used over the period of record analyzed in the DEIS).	See response to comments 5, 45, and 90
341	8/27/2024	NGO- American Rivers	Pump Operations	The Clean Water Act veto prohibits a range of operating plans, including a 14,000 cfs pumping plant with a pump-on elevation of 91-feet NGVD. The veto documents the unacceptable adverse impacts of operating the proposed pumps "during the critical spawning and reading months" in early spring and summer.9 "Spring flooding is the major factor responsible for fishery productivity within the Yazoo River Basin."10 It is also critical to many bird species that depend on the Yazoo backwater area. EPA thus vetoed the proposed operating plans because they would have reduced "the extent and duration of the spring flood pulse [which] would severely reduce the current fish productivity of the lower Yazoo Basin."11 That "reduction in the extent and duration of the spring flood pulse" would also "result in significant adverse impacts to those birds which not only utilize the Yazoo Basin, but are dependent upon backwater flooding during these periods."12 EPA also documented how a decline in the spring flood pulse would have long-term effects throughout the year, explaining that " the scientific literature strongly suggests that bottomland hardwood forests shift over time to more drought tolerant/less flood tolerant species composition when backwater flooding is significantly reduced or eliminated. This shift is important because a change in plant community not only signals a change in hydrology, but also in the habitat resources available to wildlife."13.	EPA implements CWA section 404(c) and issued the 2008 section 404(c) Final Determination concerning the Yazoo Backwater Area Pumps Project. USACE therefore cannot speak to the applicability of EPA's Final Determination. See response to comment 5.
342	8/27/2024	NGO- American Rivers	NEPA IEPR	In developing and selecting alternatives, the DEIS must also comply with the full suite of federal laws and policies designed to protect the environment. These include, the Endangered Species Act, the Clean Water Act, the Fish and Wildlife Coordination Act, the Migratory Bird Treaty Act, and the mitigation requirements applicable to Corps civil works projects that were established by § 2036(a) of the Water Resources Development Act of 2007. These mitigation requirements must be satisfied, among other times, whenever the Corps will be recommending a project alternative in an EIS.18 . The alternative ultimately recommended must also obtain a Clean Water Act water quality certification from the State of Mississippi. In addition, the DEIS is missing information critical information necessary to evaluate the significant effects of the proposed alternative including:● App. B—Public Comments (placeholder only): should supply scoping comments. ● App. C—State and Agency Comments (placeholder only): should supply scoping comments. ● App. D-2—Fish and Wildlife Coordination Act Report (placeholder only): critical for understanding Fish and Wildlife Service views on the impacts to fish and wildlife.● App. E—Programmatic Agreement (placeholder only): critical as we understand this could place controls on changes to operating plans, among other things.● App. G—Threatened and Endangered Species (placeholder only): critical for assessing impacts to threatened and endangered species.● Economic Analysis and Benefit-Cost Assessment: critical for assessing the viability of the proposed alternatives and the key beneficiaries. ● Mandatory Independent External Peer Review: critical for assessing the quality of the DEIS. The DEIS must undergo Independent External Peer Review (IEPR) as required by 33 U.S.C. § 2343. IEPR is mandatory since the Preferred Alternative would cost well over $200 million and is unquestionably controversial19 as "there is a significant public dispute as to the size, nature, or effects of the project" and "there is a significant public dispute as to the economic or environmental costs or benefits of the project."20 As the Corps is well aware, "in all cases" the IEPR review must be carried out concurrently with the project study and must be completed "not more than 60 days after the last day of the public comment period for the draft project study," unless the Chief of Engineers determines that more time is necessary.21 The Corps provides IEPR plans online, and is required by law to provide the public with information on the timing of the IEPR, the entity that has the contract for the IEPR review, and the names and qualifications of the IEPR panel members.22	See response to comments 5, 7, and 9

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343	8/27/2024	NGO- American Rivers	Alternatives	As described in Section 1 above, both Alternatives 2 and 3 include a seasonal operating plan to manage water levels between 90 and 93 ft NGVD. The DEIS does not include an actual operating plan, leaving the public with no ability to assess the actual impacts of that plan. We expect that the operating plan will include options for multiple deviations from the plan's typical parameters as USACE operating plans typically do. If the operating plan does change, project-induced impacts could increase well above the already unacceptable levels currently identified in the DEIS. It is likely that the operating plan will change. The Corps' regulations require the Corps to "keep approved water control plans up to date" including by subjecting those plans "to continuing and progressive study by personnel in field offices of the Corps of Engineers."23 The Corps' Engineering Regulations also direct that water control plans should be reviewed "no less than every 10 years and shall be revised as needed in accordance with this regulation."24 The Engineering Regulations also allow "[s]ignificant, recurrent or prolonged deviations from operations prescribed by an approved water control plan" unless the division commander decides that such deviations "indicate a need for a formal change to operations prescribed by an approved water control plan."25 The DEIS states "additional Memorandums are being developed related to Pump Operations and Monitoring and Adaptive Management of the Water management Project to establish procedures regarding efficient and effective coordination in the development, review, approval, and oversight of these plans." Unfortunately, such agreements are unenforceable and vulnerable to change and political pressure. The Yazoo Pumps have already been the subject of intense political pressure. In public comment sessions on this DEIS, pumps proponents have repeatedly stated a desire for altering the proposed operating plans to facilitate longer growing seasons in public comment sessions. When the operating plan does inevitably change, there is no requirement to notify the resource agencies or the public of any such deviations. It will also be difficult—and perhaps impossible— for resource agencies or the public to know whether the Corps is in fact following the operating plan or deviating from it during a particular flood event. As a result, the operating plan for the selected alternative cannot provide a reliable backstop for managing environmental harm or selecting the least environmentally damaging practicable alternative, as required by the Clean Water Act.	See response to comment 5 and the Memorandum of Agreements between Dept of Army, EPA, and USFWS described in this project.
344	8/27/2024	NGO- American Rivers	Wetlands	The DEIS states that Alternative 2 would have "indirect impacts" associated with changes in flood duration levels, attributed to pump station operation resulting in a loss of 34,687 Acreage Annual Functional Capacity Units (AAFCUs) necessitating an estimated 7650 acres of reforested compensatory mitigation lands, while Alternative 3 would result in a loss of 25,470 AAFCUs, necessitating an estimated 5,722 acres of reforested compensatory mitigation lands. American Rivers is concerned that this finding of impacts to wetlands, and the corresponding impacts to species, are drastically understated because the data included in Table 53 in Appendix F-3- Wetlands indicates that the impacts to wetlands and associated species, resulting from keeping water levels at or below the 90-foot elevation—the 2-year floodplain—throughout the entire migration, breeding, spawning, and rearing periods, would far exceed the Corps' estimate. The EPA has yet to release their Determination which will assess the wetland impacts of the Preferred Alternative, and the FWS has not yet released their Fish and Wildlife Coordination Act Report which will assess impacts on fish and wildlife and Threatened and Endangered Species. As Alternatives 2 and 3 will include an operating plan that will alter the timing, and reduce the spatial extent, depth, frequency, and duration of time that wetlands within the project area are inundated, these reports are expected to find that Alternatives 2 and 3 will undoubtedly result in significant impacts to the hemispherically important wetlands in the Yazoo Backwater Area and the many species that depend upon this region. The Yazoo Backwater Area "contains some of the richest natural resources in the nation including a highly productive floodplain fishery, one of only a few remaining examples of the bottomland hardwood forest ecosystem which once dominated the Lower Mississippi Alluvial Valley, and is one of only four remaining backwater ecosystems with a hydrological connection with the Mississippi River."26 Forested wetlands have long been recognized as vitally important and as being "among the Nation's most important wetlands."27 The bottomland hardwood wetlands of the Lower Mississippi River Valley: "are prime overwintering grounds for many North American waterfowl, including 2.5 million of the 3 million mallards of the Mississippi Flyway, nearly all of the 4 million wood ducks and many other migratory birds. Numerous finfishes depend on the flooded hardwoods for spawning and nursery grounds. These wetlands support many other species of wildlife, including deer, squirrel, raccoon, mink, beaver, fox and rabbit. They also play a vital role in reducing flooding problems by temporarily storing large quantities of water and by slowing the velocity of flood waters. In the process, these wetlands remove chemicals such as fertilizers and pesticides from the water, trap soil eroding from nearby farmlands, and recharge ground water supplies."28 As the EPA stated in the 2008 Clean Water Act veto of the pumps, the "construction and operation of the proposed Pumps would dramatically alter the timing, and reduce the spatial extent, depth, frequency, and duration of time that wetlands within the project area are inundated."29 The ecological implications of these changes are enormous, because hydrology is "the single most important determinant of the establishment and maintenance of specific types of wetlands and wetland processes."30	The proposed Alternatives 2 and 3 would not maintain water levels at the 90 foot elevation throughout the year, but would allow for backwater flood events to reach the entirety of the 5-year floodplain during the non-crop season in years when flood elevations on the Mississippi River necessitate closure of the downstream water control structures (e.g., Steele Bayou) and sufficient precipitation occurs within the Yazoo Backwater Area to induce a 5-year flood event. The estimated impacts to wetlands were derived using an established, certified, data-driven approach that has repeatedly been shown to effectively link remote sensing and ground-based measurements with wetland functions. The analysis was conducted using the assumptions that all areas subject to as little as one day of flood inundation are functioning as wetlands and that all non-agriculture lands experiencing flooding are highly functional mature forested wetlands. Additionally, the extensive monitoring and adaptive management plan will include long-term monitoring of conditions within the study area to ensure that 1) impacts to wetlands were not underestimated, 2) any potential unanticipated impacts to wetlands can be quantified and addressed, and 3) the establishment of wetland mitigation successfully offsets impacts to wetlands resulting from project implementation. The selected approach along with the considerations noted above promotes the responsible management of the valuable wetland resources in the Yazoo Backwater Area.
345	8/27/2024	NGO- American Rivers	Aquatics	In addition, the actual impacts from Alternatives 2 and 3 may be far greater than acknowledged in the DEIS because the DEIS fails to assess an extensive array of impacts to fish and wildlife. A full analysis of impacts to fish and wildlife is necessary given the importance of the Yazoo Backwater Area's ecologically rich wetlands to more than 450 species of birds, fish, and wildlife. EPA issued the 2008 Clean Water Act veto because the Yazoo Pumps "would result in unacceptable adverse effects on fishery areas and wildlife," highlighting the loss of spring flood pulses as of particular concern as those coincide with and support key lifecycles of fish and wildlife. Indeed, the veto "is based solely on environmental harms to fisheries and wildlife in the Yazoo Backwater Area" as "is appropriate given the structure and language of the CWA and case law."31 In the veto, EPA also noted that the U.S. Fish and Wildlife Service "concurred with EPA's conclusion that the Yazoo Backwater Area Project would result in significant degradation and unacceptable adverse effects on wildlife and fisheries resources" and expressed appreciation for the veto acknowledging "the full breadth of the proposed project's anticipated adverse impacts to its four National Wildlife Refuges located within the project area."32 A careful and robust assessment of these needs is critically important for understanding the true extent of adverse impacts to fish and wildlife because the Yazoo Pumps Alternatives will keep water levels at extremely low elevations during the time periods that are most critical for migration, breeding, spawning, and rearing.	Impacts to the fisheries were based on a 25-year monitoring database in the Yazoo River basin. This revised project accounted for impacts to spawning and rearing fishes and necessary mitigation to offset adverse impacts. The analysis used recent hydrologic data (1978 - 2020), including spring flood pulses, and improved elevation mapping data to delineate landuse types. The project will provide opportunities for overall watershed planning to improve habitat quality and increase biodiversity.
346	8/27/2024	NGO- American Rivers	alternatives	As mentioned previously, American Rivers remains concerned that the local community members requesting a whole of government solution that focuses on non-structural and nature-based approaches have not been fully considered. American Rivers continues to join our regional and local partners in urging the Corp to pursue a Resilience Alternative that utilizes the entire capability of the federal government to deliver real solutions that not only reduce flood damages but invest in the communities in the region. While the DEIS includes a fully nonstructural alternative, Alternative 4, that consists of voluntary acquisition of the 1,845 structures within the area flooded in 2019, and 137,926 acres of farmland that could be acquired via fee or easement, American Rivers is disappointed the Corps did not develop a more robust nonstructural alternative that brings together the many potential programs and resources available through the federal government to collectively build a plan that will not only reduce flood risk, but will address the systemic challenges and foster economic growth within the economically disadvantaged communities in the Yazoo Backwater Area, such as the Resilience Alternative included in Attachment 1 to these comments. The Resilience Alternative will avoid flood risks and reduce flood damages to impacted communities while protecting and restoring—instead of harming—this ecologically rich area. The Resilience Alternative unquestionably complies with the Clean Water Act 404(b)(1) Guidelines, the Endangered Species Act, and all other applicable environmental laws. The Resilience Alternative utilizes sustainable solutions that are being employed by communities across the country to reduce flood risks, including purchasing wetland reserve and floodplain easements, voluntary buyouts and relocations, and flood-proofing infrastructure. These solutions can be carried out under existing federal programs that are currently funded and available for use in the Yazoo Backwater Area, including: U.S. Department of Agriculture easement programs; Federal Emergency Management Agency pre-disaster mitigation programs (which are being consolidated under the new Building Resilient Infrastructure and Communities "BRIC" program); and Federal Emergency Management Agency post-disaster recovery programs.	Comment noted, see response to comments 1, 226, and 229
347	8/27/2024	NGO- American Rivers	General Oppositon	American Rivers calls on the Corps to respect the 2008 EPA veto of this project and end the effort to build a 25,000 cfs pumping station at Steele Bayou. The Administration's decision to reassert the Yazoo Pumps Clean Water Act veto in November 2021 opened the door for deploying demonstrably effective natural, nature-based and non-structural solutions for the Yazoo backwater Area. These solutions would reduce flood risks for vulnerable Yazoo backwater communities while protecting and restoring the region's hemispherically significant wetlands and making communities and the nation's wildlife more resilient to climate change. Local community leaders, the conservation community, hundreds of scientists, the U.S. Fish and Wildlife Service, the U.S. Environmental Protection Agency, and others have repeatedly asked the Corps to deploy these types of solutions for the Yazoo backwater area. American Rivers urges the Corps to support the prompt deployment of these types of solutions, and abandon pursuit of the environmentally devastating, dangerous, extremely costly, and long-vetoed Yazoo Pumps.	EPA implements CWA section 404(c) and issued the 2008 section 404(c) Final Determination concerning the Yazoo Backwater Area Pumps Project. USACE therefore cannot speak to the applicability of EPA's Final Determination. See response to comment 5.

Comment Number	Comment Date	Org.	Theme	Comment	Response
348	8/27/2024	EPA	General Opposition	The U.S. Environmental Protection Agency has reviewed the U.S. Army Corps of Engineers Draft Environmental Impact Statement (EIS) for the Yazoo Backwater Area Water Management Project, which was published on June 28, 2024. The draft EIS was reviewed in accordance with Section 102(2)(C) of the National Environmental Policy Act and Section 309 of the Clean Air Act. The CAA Section 309 role is unique to EPA. Among other things, CAA Section 309 requires EPA to review and comment on the environmental impact of any proposed Federal action subject to NEPA's environmental impact statement requirements and make the agency's comments public. The USACE is the lead Federal agency for the project, and the non-Federal sponsor is the Board of Mississippi Levee Commissioners. The EPA is a cooperating agency on the project. Pursuant to a Joint Memorandum of Collaboration, signed January 2023, the USACE and the EPA have worked collaboratively on the Yazoo Backwater Area Water Management Project. The USACE, the EPA, and the U.S. Fish and Wildlife Service participated in joint public engagement sessions on February 15, 2023, and May 4 and May 5, 2023. The EPA provided scoping comments to the USACE on August 7, 2023. The EPA also attended cooperating agency meetings beginning September 14, 2023, and public meetings on the draft EIS on July 22, 2024, and July 23, 2024. According to the draft EIS, "[T]he primary purpose of the project is to reduce flood risk from flooding in the lower Mississippi Delta caused by excessive standing water for long periods of time." The draft EIS also states, "[T]he proposed plan would provide significant flood risk reduction for communities in the Yazoo Backwater Study Area, or YSA, and the local economy while also avoiding and minimizing impacts to important environmental resources." The draft EIS evaluated the following alternatives: (1) Alternative 1 (No Action); (2) Alternative 2 (Crop Season 16 March – 15 October and Non-crop Season 16 October – 15 March); (3) Alternative 3 (Crop Season 25 March – 15 October and Non-Crop Season 16 October – 24 March); and (4) Alternative 4 (Nonstructural Plan Only). The draft EIS identifies Alternatives 2 and 3 as the preferred alternative. Alternatives 2 and 3 include the same structural and nonstructural components, and only differ in the dates of water level management, specifically the dates identified as the crop season and the non-crop season. The structural components of Alternatives 2 and 3 include the construction and operation of 25,000-cubic feet per second pump station, adjacent to the Steele Bayou water control structure. Water levels would be managed at 90 feet National Geodetic Vertical Datum of 1929 (NGVD29) at the Steele Bayou gauge during crop season and up to 93 feet NGVD29 during non-crop season. Thirty-four supplemental low-flow groundwater wells would be installed. The nonstructural components include full utilization of the gate operation of the Steele Bayou water control structure to optimize fisheries exchange (75.0 feet NGVD29) as described in the current water control manual. Mandatory acquisition of residential and commercial properties up to 90 feet (101 structures); voluntary floodproofing and/or acquisition of properties up to 93 feet (231 structures). Voluntary acquisition of up to 11,816 acres of cleared land at or below the 2-year floodplain, and up to 27,675 acres of cleared lands between the 2-year and 5-year floodplains, through fee or a restrictive easement. Another important component of Alternatives 2 and 3 is the development of three Memoranda of Agreement between the Department of the Army, the USFWS, and the EPA, which are to be finalized before the publication of the final EIS. The first MOA is an agreement on the final water control operations. The second MOA is a joint mitigation agreement. The third MOA is an agreement to collect and evaluate monitoring data across the YSA. Based on the review of the available information, the EPA has identified public health, welfare, and environmental quality concerns in the analysis that are recommended to be addressed in the final EIS. Alternatives 2 and 3 would have adverse impacts to the environment requiring mitigation along with an associated monitoring and adaptive management plan. Enclosed are detailed comments and recommendations regarding alternatives; aquatic resources; hydrologic, hydraulic, and water extent and duration analyses; water quality; environmental justice; air quality; costs and benefits; and transportation. Comments and recommendations regarding the Clean Water Act Section 404(b)(1) evaluation, which is needed before a Record of Decision is issued, are also included. These recommendations are intended to help improve the environmental outcome of the proposed action. The EPA appreciates the opportunity to review and comment on the draft EIS. If you have any questions, regarding our comments and recommendations, please contact Wm. Kenneth Dean, Acting NEPA Section Manager, at 404-562-9378 or at dean.william-kenneth@epa.gov, or Douglas White of the NEPA Section at 404-562-8586 or white.douglas@epa.gov.	Comment noted
349	8/27/2024	EPA	Alternatives	Including more complete information on the potential human and environmental impacts and benefits associated with each alternative. See below sections for specific recommendations.	Comment noted
350	8/27/2024	EPA	Alternatives	Including additional information and analysis to help determine whether Alternative 4 is a practicable alternative that fulfills the overall project purposes.	Concur, addional language has been added for clarity.
351	8/27/2024	EPA	Alternatives	Providing more clarity with respect to the type of nonstructural improvements that would be offered to property owners and landowners with each alternative (e.g., please clarify that each alternative would provide floodproofing).	Concur, addional language has been added for clarity.
352	8/27/2024	EPA	Aquatics	Only three of the seven terrestrial wildlife and waterfowl analyses evaluated both Alternatives 2 and 3 (Appendix F-4). To adequately review the potential environmental impacts for each alternative all analyses should evaluate losses associated with both Alternatives 2 and 3.	Clarification has been provided for Alternative 3 analysis.
353	8/27/2024	EPA	Aquatics	Using consistent naming conventions for all alternatives evaluated for improved clarity throughout the final EIS and appendices. Failing to do so could lead to confusion regarding which structural alternative is least impactful. For example, Appendices H (Water Quality) and F-6 (Aquatic Resources and Fisheries) reverse the definitions for Alternatives 2 and 3. Furthermore, all the species-specific assessments within Appendix F-4 (Terrestrial Wildlife) and Appendix F-5 (Waterfowl) refer to Alternatives 1 and 2 as the structural alternatives, and of these, they are not consistently defined. Only Appendix F-3 (Wetlands) correctly defines each alternative and includes results consistent with those naming conventions.	Alternative numbers have been corrected for all appendices.
354	8/27/2024	EPA	Aquatics	The sentence on page 5 of Appendix F-6 could cause confusion related to the area assessed for the fisheries impact assessment. It incorrectly states "For this application, only agriculture and bottomland hardwood cover types within the 2-year flood frequency were considered." Clarifying this sentence in Appendix F-6 to indicate that all potential fisheries habitat was evaluated within the 5-year floodplain and not only the 2-year floodplain.	The description of landuse was corrected in the Aquatic Appendix as follows: EnviroFish uses the landuse and elevation (cleared and forested stage-area curves) flooded every foot, every day, over the period of record, during the designated spawning season with and without pump. The without pump condition is run regardless of flood elevation up to the 5-year elevation. The with-pump condition is based on the two alternatives up to the 5-year elevation.
355	8/27/2024	EPA	Aquatics	Including Appendix D-2 (Fish and Wildlife Coordination Act Report) and Appendix G (Threatened and Endangered Species) in the final EIS. Those appendixes have not yet been released for public review and comment.	Concur, Appendix D-2 and G have been updated for the FEIS.
356	8/27/2024	EPA	Aquatics	Including a more thorough analysis of cumulative effects on aquatic resources in the YSA. A short narrative already exists in the 404(b)(1) analysis; however, a more quantitative analysis of the impacts of the MR&T project, as well as agricultural practices, in the YSA is recommended to provide a more comprehensive assessment of cumulative effects. Additionally, while the current draft articulates potential effects of wetland dewatering from FESM-based inundation estimates, the final EIS should address how the alternatives will affect soil saturation in light of decreased backwater flooding.	Concur, a cumulative impacts write up has been incorporated into Section 5.
357	8/27/2024	EPA	Aquatics	Providing information to ascertain potential water quality impacts locally and downstream, which could subsequently affect fisheries habitat and recreational opportunities. See below sections for more specific recommendations.	
358	8/27/2024	EPA	Aquatics	Further describing how supplemental low flow wells will be an effective watershed component of Alternatives 2 and 3 including results from any pilot projects and any other current information to demonstrate potential effectiveness.	The Aquatic Appendix justifies the low-flow wells based on long-term impacts to the overall flow regime in the watershed. Flood-induced hypoxia during the spring and early summer likely impacts successful spawning and rearing regardless of reforestation. The juvenile and adult life stages that do survive through the flood season are faced with extreme low flows during the fall. Re-establishing perennial flows with the supplemental low flow groundwater wells may offset high mortality of larvae and juvenile fish in the spring from hypoxia and other impacts with higher rates of survival of juveniles and adults during autumn. Protection of established mussel beds from desiccation would also be a direct benefit of the low flow wells. A conceptual model with field verification was recently published outlining this type of approach (Killgore et al 2022). This approach addresses the overall aquatic community during all life stages and would benefit and augment other mitigation measures being considered for Alternatives 2 and 3.
359	8/27/2024	EPA	Aquatics	Providing clarification to Appendix F-3 (Wetlands): • The text describing Table 1 and the inundation and saturation (page 12), e.g., "… areas estimated to flood less than 7 days based on inundation model results exhibited an average of 88 days of soil saturation over an 8-year period; study locations estimated to have 7-14 day flood inundation exhibited an average of 151 days of saturation; and areas with modeled flood inundation durations >14 days exhibited an average soil saturation period of 172 days (Table 1) …" does not suggest the influence of precipitation as claimed (e.g., the text states "… they do suggest that precipitation plays an important role in wetland hydrology, and some areas retain wetland characteristics of soil saturation regardless of (or in addition to) backwater flooding-related hydrological events"). Instead, this supports the idea that the soil saturation data does not align with the modeled flood inundation durations (sourced from the Flood Event Simulation Model) which, given the simplification of the Geographic Information System-based FESM may be incorrect or misleading. Please temper the language asserting the dominant sources of hydrology and including a more thorough discussion of how estimated modeling error might complicate interpretation of flood frequency and duration in the YSA.	The data on the role that precipitation plays in supporting wetland hydrology are clear. Errors associated with the FESM model should be addressed in the FESM section of the document. Regardless of potential errors in the model, it remains clear that wetland hydroperiods far exceed periods of flood inundation by several weeks to months within the study area. The magnitude of the differences between the hydroperiods and the flood inundations are so substantial that even if the model displayed errors of 300% the conclusion would not change. For example, areas with modeled flood inundations of 7-14 days (300% error = 21-42 days) exhibit wetland hydroperiods of 123-194 days.

Comment Number	Comment Date	Org.	Theme	Comment	Response
360	8/27/2024	EPA	Aquatics	Provide clarification for F-3 The text conflates inundation with saturation, please clarify the terminology used throughout the document to correctly represent whether conclusions are based on estimates of inundation or saturation. Inundation occurs when saturated soils produce visible surface water whereas soil saturation refers to how much water is contained within pore spaces of the soil. As the USACE wetland delineation manual notes, wetlands include areas that are saturated within 12 inches of the soil surface, and changing the surface-water inundation frequency will also likely affect the frequency of soil saturation within 12 inches of the surface.	The wetlands assessment accounts for potential decreases in soil saturation by assuming that all areas subject to any period of inundation would meet the definition of a wetland, which requires 14 consecutive days of flooding, ponding, or saturation within the upper 12 inches of the soil surface. Using this approach, areas subject to a single day of inundation are assumed to be saturated for the remaining 13 days required to meet the wetland hydrology requirement. This conservatively accounts for any potential decreases in soil saturation associated with pump operations. Additionally, due to low soil infiltration rates associated with heavy clay soils in the study area surface soil saturation depths remain limited, and evapotranspiration rates far exceed saturated hydraulic conductivities (often by an order of magnitude) during periods of flood inundation. These factors further suggest that potential reductions in saturation will not have negative impacts to wetlands. Further, the ongoing monitoring of >120 wetland groundwater monitoring sites and the proposed monitoring and adaptive management plan include the assessment of subsurface water levels. As a result, any unanticipated impacts to wetlands resulting from reduced saturation can be assessed and appropriately addressed using a data-driven approach in cooperation with our partner agencies.
361	8/27/2024	EPA	Aquatics	Provide clarification for F-3 There appear to be nearly two pages of missing text on pages 17-19 making review of Appendix F-3 incomplete. Missing text should be included in the final EIS.	Comment noted. Text has been included in FEIS.
362	8/27/2024	EPA	Aquatics	Provide clarification for F-3 The Appendix relies on National Agricultural Statistics Service data to derive estimates of the extent of wetlands in the YSA. Because NASS data is obtained during the summer, seasonal changes to inundation patterns can affect interpretation of existing land use. Specifically, certain areas designated as open water during high precipitation years may be identified as wetlands during years with more average precipitation levels, which could potentially result in some unidentified wetland functional impacts. The Appendix should include titles and dates of sources used, using citations to publicly available data where possible, and ensure that information referenced can be made available in the final EIS or on the project website if it is not publicly available elsewhere (e.g., inundation maps of the post-project floodplain, data used in NASS assessments, etc.).	The NASS data was not used to determine the extent of wetlands, only the landuse (i.e., forested wetlands vs agricultural land). The extent of wetlands was determined based on FESM results. The data was collected during 2022, which has been added to the appendix. The data is produced using satellite imagery from Landsat 8 and 9 OLI/TIRS, ISRO ResourceSat-2 LISS-3, and ESA SENTINEL-2A and -2B collected during the current growing season. Dates of data collection for the 2022 date ranged from 09/21, 10/21, 11/21, 04/22, 05/22, 06/2, 07/22, 08/22, and 09/22. The NASS water layers only include 2 categories (open water and aquiculture) that could be impacted by wetter than normal precipitation, potentially altering the wetlands assessment. During 2022, only one month (08/22) of the nine months from which data were derived was wetter than normal based on a WETS analysis of 24 years of weather data. Other months were within the normal range (4 months) or displayed lower than normal precipitation (4). This suggests that precipitation did not contribute to error within the wetlands assessment.
363	8/27/2024	EPA	Aquatics	Provide clarification for F-3 The FESM is referenced (thesis/dissertation link provided) but model input values and uncertainties of the GIS model are not considered (page 28), preventing full appreciation of the applicability of the FESM (as well as repeatability by stakeholders and collaborators). See recommendations within Section III, below, for concerns and recommendations relating to the use of the FESM GIS model.	Comment noted.
364	8/27/2024	EPA	Aquatics	Provide clarification for F-3 Percent and days of the year appear to be incorrect (page 28). For instance, 2.5% of the year corresponds to 365x0.025 = 9.125 days, while it is written as <9 days. These values should be corrected in the final EIS.	Concur, the following text has been added for clarity: "When flood duration intervals yielded a fraction of a day, the interval categories were rounded to the closest full day. For example the <2.5% interval corresponds with exactly <9.125 days, which is reported here as <9 days."
365	8/27/2024	EPA	Aquatics	Provide clarification for F-3 It is unclear if the inundation periods were applied "during the growing season" (page 29). Elsewhere in the draft EIS, it was determined that the YSA had a year-round growing season as the soil temperatures were always >5C. Therefore, the inundation period (and saturation) would be 14 consecutive days during the year, not "during the growing season". The final EIS should clarify if these were the 'modeled' inundation periods exploring periods of consecutive inundation (ignoring saturation) such as 14 days during a year (14 consecutive days during a given year of 365 days) or if they were calculated as during a growing season. If it is now a yearly analysis, the use of the term "growing season" should be removed after introducing that the growing season is year-round.	Appendix F-3 has been edited to indicate the growing season is year-round throughout. Example text includes: "All HGM calculations utilized the mid-point of each flood duration range, for example an estimated flood duration of 6.25% of the year-round growing season was applied to all land cover classes within the 5-7.5% flood duration interval."
366	8/27/2024	EPA	H&H	FESM methods and assumptions should be clearly explained, using citations and data to clearlydocument results. The final EIS should identify and state all assumptions, more clearly identifyspecific inputs, state parameters used in the model (for instance, what slope correction valuewas used), identify validation steps used to ensure that the model provides accurateinformation (including estimates of vertical error for DEMs and impacts on the modelingoutputs), and provide results of the model. While more complex than running GIS-based FESM,if FESM methodologies cannot be more clearly articulated and validated, the USACE has thepotential capability to use their existing and well-cited HEC-HMS models to produce floodingextents and duration for years that approximate the 5 year floodplain.	Concur, additional information documenting the use of FESM has been inorporated in to the report.
367	8/27/2024	EPA	H&H	Additionally, several components of the sections regarding the methodologies used to assessimpacts of pumping to wildlife and wetland flooding frequency and duration should providemore information. Apart from additional clarity, it is important that output results of extent andduration for the 90 ft and 93 ft extent for the different alternatives be included, spatiallyshowing where duration and frequency zones are found and where changes occur between thealternatives. These maps provide the spatial foundation for many of the calculated impactsincluding the Wetland Appendix Tables 53-91 and should be included in the final EIS.	Concur, additional maps have been inorporated in to the report. See response to comment 366.
368	8/27/2024	EPA	H&H	Recommendations related to the use of HEC-HMS and HEC-RAS from Appendix A:The final EIS should represent elevation data in terms of a consistent datum. There is anonline tool from the National Oceanic and Atmospheric Administration(https://geodesy.noaa.gov/NCAT/) that converts between NGVD 29 and NAVD 88.	Comment noted. However, a sensitivity analysis conducted by the Vicksburg District resulted in a difference of less than 0.2' between datums, which is within the modeling error.
369	8/27/2024	EPA	H&H	Recommendations related to the use of HEC-HMS and HEC-RAS from Appendix A: Figure and table numbers throughout the document should be corrected for accuracy andflow/order with the text. Many figure numbers are difficult to follow. For example, "Figure 2"is cited in the text multiple times and should be clarified which is which in the text. Forinstance, the line beginning with "In addition, the northern…" (Paragraph 25) has Figure 2referenced but it should be clarified as Figure 2-4.	Concur. Figure numbers have been corrected.
370	8/27/2024	EPA	H&H	Recommendations related to the use of HEC-HMS and HEC-RAS from Appendix A: Many figures, including maps, are not legible or are difficult to read and interpret. For example, Figure 2-25 is not rendered such that details and labels can be discerned.	Concur, Figure 2-25 has been revised for clarity.
371	8/27/2024	EPA	H&H	Recommendations related to the use of HEC-HMS and HEC-RAS from Appendix A: There are opportunities to include more maps that clarify information about the YSA. For example, it would be beneficial for the reader to have a reference map of the overall study area that includes locations of existing water control structures, calibration locations, proposed pumps and low-flow wells, inlet and outlet channels, and all different rivers and channels. Figure 2-5 is beneficial; however, it could be improved with additional GIS layers for reference.	Comment noted. Figures have been improved where possible for clarity.
372	8/27/2024	EPA	H&H	Recommendations related to the use of HEC-HMS and HEC-RAS from Appendix A: Plots and tables should have adequate and clear information for the reader. For example: Figure 2-53 should have axis labels to better orient the reader to the data.	Concur, Figure 2-53 has been revised for clarity.
373	8/27/2024	EPA	H&H	Recommendations related to the use of HEC-HMS and HEC-RAS from Appendix A: Lake Okeechobee is called both the largest natural and largest man-made lake (Paragraph 19). It is the former (outside of the Great Lakes), but significantly modified by levees. This should be clarified by removing it from examples of "man-made reservoirs".	Concur, document has been revised.
374	8/27/2024	EPA	H&H	Recommendations related to the use of HEC-HMS and HEC-RAS from Appendix A: Wikipedia isn't a peer-reviewed source (Paragraph 19). The YSA is not a lake or a reservoir but a system of agricultural, urban, and natural lands. These should be corrected.	Comment noted. However, Wikipedia, in this context, is used as a search engine and is cited as such. For clarity, the text states that "if the Yazoo Backwater Study Area was treated as a lake or reservoir…."
375	8/27/2024	EPA	H&H	Recommendations related to the use of HEC-HMS and HEC-RAS from Appendix A: Rather than using National Centers for Environmental Information data (Paragraph 22) for precipitation and then interpolating spatiotemporally, it would be more straightforward to use a radar-based, quality-controlled meteorological dataset like NLDAS (https://ldas.gsfc.nasa.gov/nldas).	Comment noted. The National Center for Environmental Information is a certified source of inforamtion used by USACE HQ as they directed this climate study that was completed by Vicksburg District. The data was not interpolated spatiotemporally. In paragraph 22, the source was used to gather average temperature for various months throughout the year. This section is being updated by a USACE to include additional climate change language.
376	8/27/2024	EPA	H&H	Recommendations related to the use of HEC-HMS and HEC-RAS from Appendix A: Figure 2-4 should say "Mississippi Climate Division 4 – Lower Delta" to clarify.	Concur, document has been revised for clarity.
377	8/27/2024	EPA	H&H	Recommendations related to the use of HEC-HMS and HEC-RAS from Appendix A: The Appendix states "Observed data on the Big Sunflower River at Sunflower, Mississippi, show that annual runoffs vary from about six to 41 inches and average about 24.5 inches over the drainage area" (Paragraph 27). This section should identify how runoff data were "observed".	Concur, document has been updated to note observed rainfall was obtained from the National Weather Service River Forecast Center and then the percentage of rainfall that is runoff was caculated using the runoff coefficient for the given month the rainfall occurs in.
378	8/27/2024	EPA	H&H	Recommendations related to the use of HEC-HMS and HEC-RAS from Appendix A: Appendix F-3 indicates that headwater floods typically have >1' slope between gages (Paragraph 28), while backwater floods occur only when the downstream river experiences high stages (without noting a "typical height" such as 1'). The Appendix should identify if 'headwater flood' requires a higher gage height upstream or, conversely, if a backwater flood requires a >1' slope between the downstream and upstream gage (noting the level of specificity is "a >1' slope"). The Appendix should clarify this in regard to "a true backwater flood" which has a "flat or nearly flat surface" and the period of time for a flat or nearly flat surface to emerge. The slope in the study area (Paragraph 21) is noted to be 0.3 to 0.9 feet per mile (suggesting the entirety of the basin has ~>1' slope between gages).	Comment noted. However, the term "headwater flood" is not contained in Appendix F-3. Therefore, no revisions were made.
379	8/27/2024	EPA	H&H	Recommendations related to the use of HEC-HMS and HEC-RAS from Appendix A: Backwater floods were elsewhere defined as "downstream river experiences higher stages than the tributary" and "a flat or nearly flat surface". A third definition is introduced (Paragraph 29) when (specifically) the Steele Bayou flood control structure riverside water height exceeds that of the landside, given that the landside is above 80.0' (NGVD29). That causes the gates to close preventing outflow. The flow would continue but build up and spread, with inundation occurring. Headwater floods may be assumed here to be flat or nearly flat, too, considering the landscape topography. The backwater flood should be clearly defined.	Concur, document has been revised for clarity.
380	8/27/2024	EPA	H&H	Recommendations related to the use of HEC-HMS and HEC-RAS from Appendix A: In Figures 2-11 and 2-12 the calibration plots for the 1991 flood event indicate that the model does not capture the multiple-day duration of the May flood event, instead representing it as a shorter-duration peak in flow that quickly decreases to previous levels. The same result is seen in Figure 2-14. Because the duration is a key component of a flood event, it is integral that the models can capture this. It appears this issue is not translated to the HEC-RAS model results, so it may not require additional HEC-HMS calibration. Additional context should be provided to explain why the model not capturing the 1991 and 2019 flood event durations is not a major concern for the project.	Comment noted, issue has been resolved through inter-agency coordination/communication.
381	8/27/2024	EPA	H&H	Recommendations related to the use of HEC-HMS and HEC-RAS from Appendix A: A citation should be provided for the very good to unsatisfactory rating of the Nash-Sutcliffe Efficiency metrics (Paragraph 101).	Comment noted, Appendix A has been revised for clarity.

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382	8/27/2024	EPA	H&H	Recommendations related to the use of HEC-HMS and HEC-RAS from Appendix A: The Appendix should clarify if the improved or original HEC-HMS model was used (with the"unsatisfactory" performance for Steele Bayou at Grace (Paragraph 110 and Paragraph 136)).	Comment noted, issue has been resolved through inter-agency coordination/communication.
383	8/27/2024	EPA	H&H	Recommendations related to the use of HEC-HMS and HEC-RAS from Appendix A: The Appendix should identify the vertical error associated with the 3-m LIDAR data (P119). This error is manifestly different in forested lands (e.g., BLHs) than in flat agricultural lands and paved urban landscapes, which should also be addressed (e.g., how this systematic vertical error affects the inundation elevations in the alternatives). Failing to account for this error when moving water on a low-slope area like the YSA subjects the results to significant potential error. The slope in the study area (Paragraph 21) is noted to be 0.3 to 0.9 feet per mile.	Comment noted, issue has been resolved through inter-agency coordination/communication.
384	8/27/2024	EPA	H&H	Recommendations related to the use of HEC-HMS and HEC-RAS from Appendix A: The Appendix should identify the actual goodness of fit metrics (calibration and validation) that provide estimates (Paragraph 141) and whether the calibration was satisfactory or not. "The results from the verification runs show similar discrepancies to those that were identified from the calibration runs. However, validation was considered to be appropriate because the results at Steele Bayou and Little Sunflower showed the same level of accuracy as the calibration runs."	Comment noted, however USACE deems the calibration and validation to be acceptable. Presented in the document is the process went through during the calibration and validation process. It is also noted that the validation events are producing similar results to the calibration events which would validate the findings.
385	8/27/2024	EPA	H&H	Recommendations related to the use of HEC-HMS and HEC-RAS from Appendix A: Only two parameters were analyzed for impacts on results (sensitivity), Manning's n values and precipitation (Paragraph 143). The model has numerous other sources of uncertainty and error (e.g., topography and vertical elevation error, ET error, model parameterization decisions, model structures, errors inherent in process-based models trying to represent an area as large as the YSA, etc – and the runoff model used is more prone to affecting the outcomes than the input precipitation data). These results do not "prove that precipitation was the driving force behind the uncertainty" but that it was more impactful than Manning's n values. The precipitation data may be amongst the most robust data used in the analyses.	Concur, document has been revised for clarity.
386	8/27/2024	EPA	H&H	Recommendations related to the use of HEC-HMS and HEC-RAS from Appendix A: The dates for "turning on" and "turning off" the pumps should be specified (Paragraph 145) in addition to the data for "pump-on" operations in the figures.	Concur, document has been revised for clarity.
387	8/27/2024	EPA	H&H	Recommendations related to the use of HEC-HMS and HEC-RAS from Appendix A: Table 2-21 does not support the statement (Paragraph 146), "It is important to note…". The difference between observed gage and modeled elevation is as follows: 1997 +0.3 model, 2009 +0.2 observed, 2019 +0.3 model, 2020 +0.1 model. RAS model runs were 0.2-0.3' higher in three of four runs, and 0.2 feet lower than the observed in one of four runs. Table 2-21 should be corrected.	Comment noted. However, modeled stages are slightly higher than the observed stages. When using the frequency analysis, USACE the higher data set to produce a more conservative estimate of frequency stages than if using the observed data set.
388	8/27/2024	EPA	H&H	Recommendations related to the use of HEC-HMS and HEC-RAS from Appendix A: While Figures 2-106 to 2-109 show the influence of the pump on extent, there are no similar figures for Alternative 3. There are no maps to accompany Table 2-29 and show the results of the difference in growing season. To compare the effects of different alternatives, maps representing the model results for Alternative 3 should be added here.	Comment noted. However, comparing Table 2-28 and Table 2-29, the only year and location where the alternatives differ in reduction is greater than 0.5' is at Steele bayou in 1997. For 2009, 2019, and 2020, there is no difference in reduction of water levels when comparing alternative 2 and alternative 3.
389	8/27/2024	EPA	H&H	Recommendations related to the use of HEC-HMS and HEC-RAS from Appendix A: More information is needed to evaluate potential increases to flooding downstream(Paragraph 158). Although the Appendix provides relevant information on this page, it shouldalso provide information like the hydrologic and hydraulic analysis that was reported inNovember 2019 but updated to reflect the currently proposed alternatives.	Concur, additional information has been included to discuss potential impacts to downstream communities.
390	8/27/2024	EPA	H&H	Recommendations related to wildlife and wetland impacts and FESM methedology in Appendix A: Overall, FESM methods and assumptions should be clearly explained, using citations and data to clearly document results. Information that is the same as presented in previous iterationsof the project could be referenced by citation. Other new information needs to be clearlyexplained in the final EIS.	Concur, additional information has been added to Appendix A for clarity.
391	8/27/2024	EPA	H&H	Recommendations related to wildlife and wetland impacts and FESM methedology in Appendix A: Identify the vertical error for the Digital Elevation Model and inundation tools used, as areasare being determined for as small as 8" of vertical change (Paragraph 166). Spreadsheets arereferenced but do not appear to be available or linked within the draft EIS. These should bemade available in the final EIS.	Concur, additional information has been added to Appendix A for clarity.
392	8/27/2024	EPA	H&H	Recommendations related to wildlife and wetland impacts and FESM methedology in Appendix A: It is unclear what is meant by the five wetland profiles (Paragraph 167-169). An example mapof those profiles should be provided.	Concur, example figures have been added to Appendix A.
393	8/27/2024	EPA	H&H	Recommendations related to wildlife and wetland impacts and FESM methedology in Appendix A: The paragraph ending with "The FSEIS examined all potential wetland areas within the 5-yearfloodplain subject to flood inundation." appears to be incomplete (Paragraph 169). Pleaseclarify whether referring to this draft EIS or if referring to the 2007 final supplemental EIS.Please also identify if this indicates (as was also stated in the Wetland Appendix) that allpotential land covers both natural lands and agriculture within the 5-year floodplain wereexamined as potential wetlands, or if this project examined all potential wetlands within the5-year floodplain subject to flood inundation and treats all those areas as potentiallyimpacted wetlands.	Comment noted. These paragraphs were deemed redundant and removed from the report.
394	8/27/2024	EPA	H&H	Recommendations related to wildlife and wetland impacts and FESM methedology in Appendix A: Wetland mapping is unclear as a stand-alone section in this document (Paragraph 170). TheAppendix should identify what gages were used and where and at a minimum refer back toother tables and figures that describe the gages and their locations. It should also identifywhat water surface elevations were used and how were they determined. This can beassumed from the HEC-RAS modeling, but it should be stated explicitly, including what linesare being junctioned and which DEM is used and its provenance (and vertical error).	Comment noted. Table 2-31 lists the gages used in the wetland assessment. Paragraph 188 states that the RAS daily stages were used and vertical error is discussed in paragraph 119.
395	8/27/2024	EPA	H&H	Recommendations related to wildlife and wetland impacts and FESM methedology in Appendix A: While Paragraph 170 attempts to include raster output details they are confusing. It shouldidentify values and which alternatives were "run" specifically, how wetland zone maps werecombined and their programs and resolution. This section could also incorporate the NoAction Alternative and Alternatives 2 and 3 wetland zones and composite wetland mapsresulting from FESM analysis spatially showing where duration and frequency zones are foundand where changes occur between the alternatives. Information that is the same aspresented in previous iterations of the project should be referenced by citation, including thatfor the model and the overall methodology.	Concur, additional information has been added to Appendix A for clarity.
396	8/27/2024	EPA	H&H	Recommendations related to wildlife and wetland impacts and FESM methedology in Appendix A: A table indicating the surface stages for the five flooding frequencies and five durationintervals should be provided for the base year and alternatives so that the model could bereproduced (Paragraph 170).	Comment noted. The stages are provided in the Wetsort_RAS_Sep2023.xlsx file, which is provided on the Project Website.
397	8/27/2024	EPA	H&H	Recommendations related to wildlife and wetland impacts and FESM methedology in Appendix A: Two files or worksheets are referenced in Paragraph 170 but are not linked or appearunavailable. "The results of the queries of all maps are provided in the"NASS22_SepWetlands.xlsx" file. The notes worksheet has a matrix of the possible grid-cellvalues." The inclusion of both a table with input parameters, and maps of results may beincluded in these documents but are not available within the draft EIS. These should be madeavailable in the final EIS.	Concur, the tables and maps are included in Appendix A.
398	8/27/2024	EPA	H&H	Recommendations related to wildlife and wetland impacts and FESM methedology in Appendix A: Paragraph 182 references a verbatim section that should be clarified.	Concur, document has been revised for clarity.
399	8/27/2024	EPA	Water Quality	Providing a more robust writeup and discussion to address all applicable water quality criteriathat apply in the project area.	Comment noted, document has been revised for clarity. Refer to Section: 1.2 MDEQ WATER QUALITY STANDARDS 1.3 MDEQ TMDL AND 303(d) LISTINGS
400	8/27/2024	EPA	Water Quality	Providing additional qualitative and quantitative information to address the specific feedbacklisted below.	Comment noted, document has been revised for clarity.
401	8/27/2024	EPA	Water Quality	Providing a water quality model to generate more quantitative conclusions on the impacts,both inside the levee gates within the primary receiving waters and downstream of the projectarea.	Comment noted. However, a Water Quality Model was not utilized for this EIS. Questions related to impacts for delivery of nutrients and dissolved oxygen from inside the YBA to outside the YBA (Mississippi River) were quantitfied in Section 4.0 DOWNSTREAM IMPACTS
402	8/27/2024	EPA	Water Quality	Recommendations related to water quality criteria: Section 4.2.2.8.2 of the main draft EIS document refers to the EPA's recommended criteriafor dissolved oxygen (DO), but it is applicable to refer to Mississippi's water quality criteriafor DO, and any other relevant criteria related to impacts associated with the proposedalternatives. The USACE should collaborate with the Mississippi Department ofEnvironmental Quality to ensure all applicable parameters (and associated water qualitycriteria) are covered accurately. For example, the DO discussion should reflect the applicablestate DO criteria which is that DO "shall be maintained at a daily average of not less than 5.0mg/l with an instantaneous minimum of not less than 4.0 mg/l."	Comment noted, please refer to Section: 1.2 MDEQ WATER QUALITY STANDARDS of the water quality appendix which includes this information.
403	8/27/2024	EPA	Water Quality	Recommendations related to water quality criteria: It would be appropriate to include a reference to the applicable free from narrative tosupport additional discussion of nutrient concentrations. A(3) in Mississippi's Rule 2.2. saysin part, "Waters shall be free from materials attributable to municipal, industrial,agricultural, or other discharges producing color, odor, taste, total suspended or dissolvedsolids, sediment, turbidity, or other conditions in such degree as to create a nuisance, renderthe waters injurious to public health, recreation, or to aquatic life and wildlife, or adverselyaffect the palatability of fish, aesthetic quality, or impair the waters for any designated use."While the EPA is aware that the addition of the pump system is expected to improve waterquality concentrations for various parameters, it is also widely understood that the system islimited in its ability to completely attain the water quality criteria at all times due to themodified landscape in combination with naturally occurring conditions. A betterquantification of the improvements identified in the alternatives and how they compare toMississippi's relevant water quality criteria could be determined with a Water Quality Model.	Comment noted. Please refer to Section: 1.2 MDEQ WATER QUALITY STANDARDS of the water quality appendix which includes this narrative. Additionally, other forms of analysis were utilized to develop an understanding of water qulaity impacts instead of a Water Quality Model.
404	8/27/2024	EPA	Water Quality	Recommendations related to water quality criteria: Coordinate with Mississippi water quality standards staff to determine whether differentcriteria than above should apply to certain waterbodies, such as those for ephemeralstreams, which have different criterion for DO and certain other parameters. Additionally,the State recently adopted additional designated uses for Drainage Waters and for ModifiedFish and Wildlife, which in the future may be more appropriate designated uses forwaterbodies in the project area. While adoption of new designated use(s) and criteria wouldnot be feasible in the near term, discussion with water quality standards staff in Mississippican best inform what should be considered now and in the future.	Comment noted. Please refer to Section: 1.2 MDEQ WATER QUALITY STANDARDS of the water quality appendix. Narratives for 'new designated uses" were included along with correspondance email with MDEQ staff via email (Attachement 1).

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405	8/27/2024	EPA	Water Quality	Recommendations related to water quality criteria: It should be noted that with respect to CWA 401 water quality certification, Federal agenciescan coordinate early and often with neighboring jurisdictions downstream of the proposeddischarge. It is important to understand that the certifying authority's certification (in thiscase Mississippi) decision itself may or may not be the right venue to address those issues ofa downstream neighboring jurisdiction's issue (i.e., Louisiana). The certifying authority(MSDEQ) is only certifying Mississippi water quality requirements and not another(Louisiana) jurisdiction. Please note that if the state of Mississippi either waives or certifiesthe water quality certification, the USACE must notify the EPA Region 4 within 5 days. TheEPA would then have 30 days to consider "may affect" the water quality requirements ofLouisiana and so notify the state. Louisiana would then have 60 days to determine whetherthe discharge will violate its water quality requirements.	Concur. A narrative was included in the water quality appendix (Section 1.5) to describe the process put forth on MDEQ's website.
406	8/27/2024	EPA	Water Quality	Recommendations related to qualitative and quantitative information: Most of the quantitative information is generally focused on what will take place in the nearfield, within the basin. While there is discussion of settling out of suspended solids andpotential for less decrease in DO values if water levels are reduced, there is not enoughquantified discussion of the downstream impacts of the increased volume of water that willbe pumped downstream as part of Alternatives 2 and 3. For example, Section 5.2.8 notes thatAlternative 2 "is not anticipated to increase the total loading of [total phosphorous] and [totalnitrogen] to the Mississippi River." Additional discussion and quantification of the potentialdifference in timing and volume relative to a no pump scenario when structures are openedversus the timing and volume associated with Alternatives 2 and 3 would be useful to expandon any potential for downstream impacts.	Concur, Section 4 of the water quality appendix has been revised for clarity.
407	8/27/2024	EPA	Water Quality	Recommendations related to qualitative and quantitative information: The nutrient information summarized in Section 4.2.2.8.1, notes the concentrations in the Yazoo are lower than those in Midwest Tributaries, below the National Median Concentrations published by the U.S. Geological Survey, and "does not contribute a disproportionate load of nitrogen to the Gulf of Mexico and is generally in line with its proportionate contribution of phosphorus to the Gulf of Mexico." The section also highlights the seasonal cycle of higher to lower nutrient concentration values from early in the year to later in the year before discussing the generalized reductions tied to best management practices efforts over time in the basin. The final EIS should identify how the Yazoo basin specific nutrient levels relate to the potential to cause or contribute to any impact(s) on response variables such as chlorophyll production or diurnal DO swings. Since there are currently no numeric nutrient criteria applicable to this part of the State, the final EIS should identify how the nutrient levels compare to available Mississippi water quality specific guidelines for protection of the water quality criteria for nutrients.	Comment noted. Please refer to Section 2.5 SUSPENDED SOLIDS of the water qulaity appendix which states: "As previously noted, the backwater pools grow deeper and sustain prolonged periods of stagnation, the suspended solids have an opportunity to settle out of the water column which corresponds to increased light transmission through the surface layer and the increased production of algal productivity. As a result, DO concentrations begin to recover within the first 5 to 10 feet of surface. Furthermore, this condition may be exacerbated in the flood pool by the nutrient availability from the upper watershed which may in turn exhibit greater extremes of high and low DO concentrations in the diurnal regime. "
408	8/27/2024	EPA	Water Quality	Recommendations related to qualitative and quantitative information: DO information in Section 4.2.2.8.2 summarizes how lower levels, exacerbated by higher temperatures and lower flows, "impose a severe impact on the overall health of the aquatic ecosystem" and Paragraph 39 in Appendix H (Water Quality) indicates the pumps "will help increase DO in the water column by minimizing the overall depth of a flood event and improving diffusion from the surface water of the interior backwater." These expectations are supported by observations from multiple-depth DO sampling plots (Figures 2-7 to 2-10), with notes that photosynthesis explains some periods of elevated DO when looked at within a day, and water depth plots against DO concentrations (Figures 2-5 and 2-6). However, additional data that can quantify the expected level of improvement in DO with the operation of the pump in Alternatives 2 and 3 would be beneficial. Additional quantification of any potential impacts resulting from releases of low DO water, over a shorter duration and higher volume, on downstream waters, should also be included in the comparison of alternatives.	Concur. Additional information has been included in Section 4.0 of the water qulaity appendix to graphcally represent instantatneous, non-uniform delivery of depressed dissolved oxygen to the Mississippi River using the Steele Bayou and Little Sunflower River Outlet Structures only (current condition). This is contrasted with the tempered use of the 25,000 cfs pump station which delivers a more uniform volume and depressed loading of Dissolved Oxygen to the Mississippi River. This comes at the expense of additional time added to the front end of the flood event. Whle the overall "DO loading" of depressed DO concentration flow from the YBA is minimal when compared to the Mississippi River, the later condition is believed to be better for assimilation purposes.
409	8/27/2024	EPA	Water Quality	Recommendations related to qualitative and quantitative information: Regarding turbidity, the draft EIS notes that stagnation creates the conditions where suspended solids can settle out of the water column. Section 5.2.8 states that "sediment disturbances during construction of the Yazoo Backwater Pump may cause temporary increases in turbidity." The final EIS should identify if turbidity associated with erosion is best addressed (and is it expected to be addressed further in the future) through BMPs to minimize sediment availability at the various flooding levels.	Comment noted. Localized turbidity increases will be minimized through the use of BMP's and construction activities as described in Section 1.3 MDEQ TMDL AND 303(D) LISTINGS sub section titled Project Impact on Water Bodies Impaired by Sediment.
410	8/27/2024	EPA	Water Quality	Recommendations related to qualitative and quantitative information: The draft EIS explains that the operational plan for supplemental low flow groundwater wells is intended to help during critical low flow periods, is not available for irrigation "which would hamper the overall benefits to the project," and represents the goal to "establish [base flows] for the region which will mimic flows observed in the mid-20th century in the Yazoo basin." Paragraph 81 in Appendix H further elaborates that the additional flows will supplement existing flows to a rate of 0.1 to 0.2-cfs per square mile for the applicable watersheds. Additional discussion on the rationale for the selection of these endpoints, including any critical assumptions made, to support the conclusion that operation in this manner will "support year-round channel geomorphology conditions, provide the necessary water quality conditions for aquatic life, and maintain adequate inundation for mussel beds" would be useful to include in the final EIS. The expectation to not operate the wells during major flood events and the general discussion regarding monitoring and management of the wells post-construction with adaptive management will be important if one of these alternatives is selected for implementation.	Concur. Language has been added to better describe implementation and operation of the supplemental low flow wells. A more descriptive narrative was given describing the desired flow per drainage area factor given in the report. This is found in Section 5.3 SUPPLEMENTAL LOW FLOW GROUNDWATER WELL SITES; this section draws the reader to a more comprehensive review of historical flow data and base flow which is found in the Engineering Appendix - Low Flow in Delta Streams.
411	8/27/2024	EPA	Water Quality	Recommendations related to the water quality model: Correcting the dates listed for Alternatives 2 and 3 on page 8 of Appendix H.	Concur, the dates have been corrected.
412	8/27/2024	EPA	Water Quality	Recommendations related to the water quality model: Page 12 of Appendix H indicates that the most recent iteration of the third Mississippi andAtchafalaya River Basins SPARROW model "is believed to corroborate the premise that theYazoo Basin is not a disproportionate contributor to the nutrient loading of the Gulf HypoxicZone." Please provide a citation for this statement.	Comment noted. The reference statement was removed from the document after inclusion of the findings from the third State (MS) SPARROW model.
413	8/27/2024	EPA	Water Quality	Recommendations related to the water quality model: Discussion of potential water quality impacts would be improved with quantitative supportfrom an updated water quality model. Review of previous documents on the project indicatethat a Water Quality Analysis Simulation Program model was developed in support of the2007 report, and it may be beneficial to update that model in order to increase support forstatements made in Appendix H. Alternatively, providing additional details on development ofthe MARB SPARROW model can increase confidence in inferences from it in the event of notincorporating a larger water quality model.	Comment noted. The water quality model used in the 2007 report was adapted from the model built to support the Big Sunflower Maintenance Project which was consequently never implemented. This adaptation was tailored to look at the potential impacts on dissolved oxygen of adopting a change in the STeele Bayou gate operation from an elevation of 70.0 feet to 73.0 feet. While the proposed project will include an adaptation for gate operation from 70.0 to 75.0 feet, the implementation will follow an Adaptive Management strategy which is closely aligned with the 3 MOA's to best suit the local aquatics.
414	8/27/2024	EPA	Water Quality	Recommendations related to the water quality model: Expanding discussion of Figures 2-15 and 2-16 in Appendix H to fully discuss yellow shadedtime periods shown in these figures.	Concur, additional verbage was added for clarity.
415	8/27/2024	EPA	Water Quality	Recommendations related to the water quality model: Section 5.2.1 of the draft EIS states "water quality could improve as well as a reduction in theamount of sediment carried into streams" via existing programs (Conservation ReserveProgram and Wetland Reserve Program). The final EIS should identify if these reductions willcontinue to occur if other alternatives are selected.	Concur, please refer to Section 3.2 PHOSPHORUS "The continuation of these programs will likely continue throughout the YBA at the funding discretion of Congress and are not directly tied to the implementation of this project."
416	8/27/2024	EPA	EJ	The final EIS should include information about persons with disabilities and individuals with limited English proficiency that may be affected by the project in Section 4.2.1.2. According to the EPA's EJ mapping and screening tool, EJScreen 2.3, there is a census block group in Sharkey County that is in the 92nd percentile for the state for limited English population, indicating it has a greater proportion of people who do not speak English than other parts of the state. EJScreen data further reveals that 100% of the limited English population in the county speak Spanish.	Concur, information has been added to the EIS for clarity.
417	8/27/2024	EPA	EJ	The final EIS should describe how the positive impact of the proposed action to agriculture production will benefit communities with EJ concerns. The final EIS analysis of agricultural and farm job benefits to communities with EJ concerns should describe who was affected by historical farm job loss in the study area and the reason for the loss of farm jobs (flooding, new technology, farm owners reduced workforce, etc.) and describe the number of farm jobs that will become available to residents from communities with EJ concerns due to the reduction in crop inundation that may benefit the agriculture industry as a result of this project. The final EIS also should identify, analyze, and address barriers that could impair the ability of communities with EJ concerns to receive equitable access to human health or environmental benefits from the project in accordance with section 3.a.iv. of EO 14096.	Concur, additional information on the farming industry, including trend data on number of farm jobs in Issaqauena and Sharkey Counties, and what is behind the loss of farm jobs, has been added to the EIS for clarity.
418	8/27/2024	EPA	EJ	In the final EIS, describe existing health, environmental and social burdens (baseline conditions), as well as those caused by climate change, in the communities with EJ concerns affected by the project and whether the project may exacerbate existing burdens or result in additional indirect, direct, and cumulative impacts to communities with EJ concerns due to existing and foreseeable conditions.	Concur, information has been added to the EIS for clarity.
419	8/27/2024	EPA	EJ	Including information on indicators from Council on Environmental Quality's Climate and Economic Justice Screening Tool used to identify disadvantaged communities, which includes information on climate change, health, energy, housing, transportation, waste and wastewater, legacy pollution, workforce development burdens. Please use EJScreen to understand, in greater detail and at a smaller scale, potential EJ concerns. The tool provides information on environmental burden and socioeconomic indicators as well as pollution sources, health disparities, critical service gaps, and climate change. The data is displayed in color-coded maps and standard data reports which feature how a selected location compares to the rest of the nation and state.	Concur, information has been added to the EIS for clarity.

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420	8/27/2024	EPA	EJ	Identifying, analyzing, and addressing historical inequities, systemic barriers or actions related to federal regulations, policies, or practices that have influenced existing conditions by impairing the ability of communities with EJ concerns in the study area and downstream of the project to achieve or maintain a healthy and sustainable environment. Include any information related to the history of poverty, racial discrimination, and legacy pollution in the area that has affected where populations live in the study area, their exposure to environmental pollution and hazards, and their baseline health conditions and social vulnerability.	Origins of Current Inequalities The historic pattern of land use, and associated social and legal frameworks, that originate from the pre-civil war plantation economy established racial disparities experienced by minority communities in the study area that persist to the present day. Examining the historic land uses from plantation farming to share cropping and later to agricultural business farming provides a window into historic inequalities, systemic barriers, and local, state and federal policy discrimination against African Americans in the study area. The Sharecropper system was established during reconstruction from the American Civil War utilizing previously enslaved individuals to conduct the bulk of the labor and largely did not allow land ownership. There were 28 plantations prior to the Civil War in Issaquena County; Sharkey County did not exist. Lands making up the county were taken from Issaquena, Warren, and Washington counties that contained at least 36 different plantations. Demographically, prior to the Civil War these 57-93 percent of overall populations per county were enslaved. Between 1900 and 2000, approximately 65-85 percentage of overall population was African American. In line with the plantation and sharecropping economic systems, while Caucasians/whites made up a small percentage of the population, more Caucasians/whites than African Americans owned land and each owner held more acres per person. Those newly freed individuals who were able to acquire land generally held small farms, rather than large tracts of land. Sharkey County, founded in 1876, began as an area with large numbers of African Americans and a high concentration of cotton. In the county's first census in 1880, 4,893 African Americans made up 77 percent of the population. By 1900 the county had 12,178 residents, 88 percent of them African Americans. By 1930 Sharkey's population of roughly 14,000 was about 78 percent African American. Not surprisingly, this rural, agricultural setting was dominated by sharecropping and tenancy, typically resulting in large numbers of farmers and small farm sizes (in 1900 the average Sharkey County farm was only fifty-five acres). Sharkey was one of seven Mississippi counties in which tenant farmers operated at least 90 percent of the farms, and African Americans comprised almost 90 percent of those tenant farmers. This translates to very low numbers of African American landowners. In 1900, 90 of the county's 222 Caucasian/white farmers (41 percent) owned their land, while only 73 of 1,821 black farmers (4 percent) did so. The Mississippi Delta experienced significant population declines from the 1930s through the 1950s, and by 1960 Sharkey County had just 10,738 residents, 70 percent of them African Americans. Agriculture continued to dominate the economy, with 57 percent of Sharkey's working people involved in farming, primarily growing cotton, wheat, soybeans, and oats. By 1970, Sharkey County's population again fell below 10,000. This trend continued into the early 21st century and endemic of the dramatically decreasing habitation of the Mississippi Delta in general. In fact, Sharkey County experienced one of the greatest proportional decreases in the state, shrinking by more than 50 percent between 1980 and 2010, making Sharkey the second-smallest county in Mississippi by 2010, with only 4,916 residents. It is well document that local, state, and federal policies practiced discrimination against African American and other groups in denying them access to loans or other assistance programs established by the Federal government. As recently as August 2024, the USDA issued a $2.2 billion assistance program for these communities. From this settlement nearly 45,000 farmers from around the country, but with most payouts going to farmers in Mississippi and Alabama – will receive payouts up to $500,000. Average payouts are reported to be around $82,000. This payout provides farmers financial assistance after years of racial discrimination, protests, lawsuits and failed legislation (Phounsavath, 2024). Tom Vilsack, Secretary of Agriculture has stated that, "[t]his financial assistance is not compensation for anyone's loss or the pain endured, but it is an acknowledgment by the department [of decades-long discrimination]"(Bustillo, 2024). In addition to pay outs, the efforts of the National Association of Black Farmers, have changed the way the US Dept. of Agriculture administers its loan programs, according to the agency, The new policy creates a set-aside program with reduced interest rates, provides flexible payment terms and reduces loan security requirements, so fewer farmers will have to use their personal property as collateral " (Phounsavath, 2024). Still, not all farmers are able to access credit on favorable terms, for example a Black Louisiana Sugarcane farmer in Louisiana, has join the original complaint alleging that the loss of the family land due to lack of access to credit is not an isolated incident. "Instead…it symbolizes a broader trend familiar to Black farmers across both the Southern region and the entirety of the United States. Consequently, the number of Black farmers continues to dwindle. According to the latest available Census of Agriculture data, only one in 100 farmers is Black, owning a total of less than 5 million acres" Staff A (2024). This legacy, as represented in the Yazoo Delta means that environmental justice communities have baseline social vulnerability due to long-term economic conditions that have been exacerbated by repeated flooding.
421	8/27/2024	EPA	EJ	Explicitly describing any cumulative impacts identified that may affect communities with EJ concerns for each alternative and whether they will have disproportionate and adverse effects. The cumulative impact analysis should consider baseline conditions in communities, past and reasonably foreseeable future projects, and ongoing and projected climate change.	Concur. USACE proposes to identify other projects taking place and their imapct on ej areas and how this current project could add to that. See response to comment 420.
422	8/27/2024	EPA	EJ	When discussing the impacts of the no action alternative in communities with EJ concerns, the draft EIS states that "flooding has caused undue hardships and economic losses to residents of the area due to flooding of homes, disruption of sanitation facilities, lines of communications, and transportation and subsistence fishing" (page 106). The final EIS should describe under each alternative how non-residential structures, such as sanitation facilities, roads, communication lines, will be impacted under each alternative and not just the no action alternative and whether and how the action alternatives will contribute to or minimize any disproportionate and adverse effects to communities with EJ concerns. For example, the final EIS should include information on the number of roads that may be flooded or not flooded at different flood levels (90 ft, 90 ft to 93 ft) as a result of the project, describe any impacts to community cohesion, such as relocation of businesses or other non-residential structures utilized by local communities, and critical infrastructure such as sanitation facilities, communication lines, schools, and health care facilities.	Concur, language has been added to the EIS to clarify that sanitation facilities, lines of communications, and transportation infrastructure in the 93-98.2 extent will benefit from a lowering of flood stage with pumps in place. Also, the ej report states that these features will benefit during the crop season, when water is pumped to 90'. Finally, these features will not benefit if located in between 93 and 90 feet flood extent, during non crop season and in the the less than 90' extent year-round. Specific roads continuing to flood or would no longer flood will not be identified; however, general area descriptions will be provided that may see reductions in flooding.
423	8/27/2024	EPA	EJ	The draft EIS states that there will be both direct benefits to communities with EJ concerns communities in the form of increased opportunities for hunting and fishing but does not include information on how community members currently utilize these resources. The final EIS should describe how community members currently utilize these resources to demonstrate the benefit of the expansion of hunting and fishing opportunities.	Concur, information on hunting and fishing licenses issued to residents of the two coounties has been added to the EIS.
424	8/27/2024	EPA	EJ	Table 5-1 identifies structures that will be affected by mandatory buyout, voluntary buyout, and flood risk mitigation as a result of the pumps, and which of these structures lie in disadvantaged communities. However, the table does not specify how many structures in each category are residential structures (though some information about residential structures facing buyouts is explained in the text). The majority of structures eligible for voluntary or mandatory relocations are located in disadvantaged census tracts (52 of 55 residential structures in the 90-foot level of inundation and 80 of 95 residential structures in the 90-93-foot inundation level (page 106)). The Final EIS should include a detailed analysis, consistent with the recommendations below, of the potential impacts of the proposed mandatory and voluntary relocations and alternative mitigation measures that do not involve relocation. The final EIS should also describe in detail the proposed mitigation measures to address relocation.	Concur, the EIS will further describe EJ impacts from a voluntary buyout plan. However, the EJ report does not offer alternative mitigation measures that do not involve relocation. That information will be included in the Plan Formlation Seciton.
425	8/27/2024	EPA	EJ	The draft EIS states that there will be mandatory buyouts of 52 residential structures and voluntary buyouts of 80 residential structures within disadvantaged communities. The section that discusses the Uniform Relocation Act requirements, states that owner occupants and tenants will be eligible to receive relocation benefits and advisory services, and that detailed information on this plan will be developed during the design phase of the project which is not subject to public notice and comment. A full disclosure of possible benefits should be provided in the final EIS to provide opportunities for the public to review and provide comments.	Concur, although a complete discussion of the implementation plan for the voluntary buyout will not be available for the Final EIS. However, general information on the voluntary buyout plan will be proivded in the FEIS with more details to follow post FEIS.
426	8/27/2024	EPA	EJ	Reduction of flood potential for the homes of those eligible for relocation is listed as a benefit of the project for disadvantaged communities, but the draft EIS does not demonstrate that there are homes outside of any floodplain that are of similar value to the homes being bought out. The draft EIS also does not discuss or address impacts on communities caused by relocation, such as changes in access to work, school, places of community gathering, and access to a customer base for business owners and does not describe whether this will cause a disproportionate impact. A housing market analysis should be completed, including available housing stock, average pricing, school availability, and proximity of houses to each other and the current employers of the community members in the study area, and be included in the final EIS.	Concur, a general housing market analysis will be provided in the FEIS.
427	8/27/2024	EPA	EJ	The final EIS should update Table 5-1 to clarify the number of residential structures in each category, clearly stating the proportion of residential structures that will benefit from pump flood risk mitigation that are in disadvantaged communities.	Concur, information has been added to the EIS for clarity.
428	8/27/2024	EPA	EJ	The final EIS should describe the relocation benefits to commercial property owners and tenants, paying close attention to small and medium sized businesses.	Concur, information has been added to the EIS for clarity.

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429	8/27/2024	EPA	EJ	The final EIS should discuss the benefits and adverse impacts of mandatory and voluntary relocation and mitigation measures and address unavoidable impacts. The final EIS should disclose mitigation options required by the Uniform Relocation Assistance Act and Real Property Acquisition Policies Act. The final EIS should also disclose and consider any additional measures beyond the requirements in the beforementioned acts that would ensure a broad range of relocation benefit reach affected communities with EJ concerns. When identifying and adopting appropriate relocation mitigation measures, the final EIS should consider possible inequities and systemic barriers, that may be borne by the communities in the project area, such as red lining and financial discrimination, that have impacted their opportunities for property ownership, access to housing, and starting a business in accordance with the directives in Section 3.a.iii of EO 14096.	Concur. Language has been added to the EIS describing NS measures and potential for adverse disproportionate imapcts and potential URA benefits. Additionally, other mitigation measures will be developed during future EJ outreach meetings between final EIS and PED, concurrent with a Real Estate implementation plan.
430	8/27/2024	EPA	EJ	Additional mitigation measures include but are not limited to: Advisory services and relatedsupport before, during and after relocation, available in multiple languages; Develop andimplement a targeted engagement plan that is accessible for persons with disabilities andlimited English proficiency to educate qualified individuals how to apply for voluntaryrelocation benefits; Providing an outreach coordinator that could assist community membersthrough the mandatory and voluntary relocation process with the utilization of the benefitsprovided by law. The coordinator could partner with trusted community organizations such asfaith-based organizations, nonprofits, and others, for assistance with the outreach.	USACE thanks EPA for these measures which can be addressed during EJ outreach meetings and in the implementation plan. Translation services will be offered if determined to be needed. USACE will coordinate with the public involvement specialist. It is well documented that local, state, and federal policies practiced discrimination against African American and other groups in denying them access to loans or other assistance programs established by the Federal government. As recently as August 2024, the USDA issued a $2.2 billion assistance program for these communities. From this settlement nearly 45,000 farmers from around the country, but with most payouts going to farmers in Mississippi and Alabama – will receive payouts up to $500,000. Average payouts are reported to be around $82,000. This payout provides farmers financial assistance after years of racial discrimination, protests, lawsuits and failed legislation (Phounsavath, 2024). Tom Vilsack, Secretary of Agriculture has stated that, "[t]his financial assistance is not compensation for anyone's loss or the pain endured, but it is an acknowledgment by the department [of decades-long discrimination]"(Bustillo, 2024).
431	8/27/2024	EPA	EJ	Including additional information on downstream impacts and identify whether there are anydisproportionate and adverse effects from the project on communities with EJ concernsdownstream of the study area. Describe the demographics and socioeconomic characteristicsof populations in the downstream area in the affected environment section (Section 4.2.1.2),any existing health, environmental and social burdens, and how downstream flooding ofstructures and roads may directly, indirectly, or cumulatively impact these communities withthe projected downstream flood levels that may result from the project.	Language has been added to the EIS regarding downstream impacts noting minimal effects and no structures will be impacted downstream. See response to comment 6.
432	8/27/2024	EPA	EJ	Discuss whether any modeling indicates downstream flooding will exceed the extent of the2011 flood and how this will affect structures that remain in the area, both within the pastflood extent and any areas outside of the 2011 flood extent. The final EIS should describe anylimitations of the modeling presented on page 110, how the ongoing and reasonablyforeseeable effects of climate change and future development patterns may affect theMississippi River modeling and projected flood extent, and any resulting impacts tocommunities	See response to comments 6 and 431.
433	8/27/2024	EPA	EJ	A third-party expert consultant challenged the integrity of the model used to assess thedownstream impacts of the pumps, arguing that it underestimates the resulting potentialincrease in downstream flooding (specifically, the impacts in the majority Black neighborhoodon the north side of Vicksburg). The final EIS should provide an explanation to this analysis inthe Engineering Appendix.	Comment noted. Language has been added to Appendix A for clarity. See response to comment 6.
434	8/27/2024	EPA	EJ	For any disproportionate and adverse impacts identified by the final EIS, the final EIS shoulddisclose and adopt mitigation measures, developed with community input asappropriate, consistent with EO 14096 Section 3(a)(i).	Concur, EJ outreach and meetings will occur post final EIS and prior to engineering and design phases that will discuss the adverse disproportionate impacts and engage with community regarding potential mitigation measures.
435	8/27/2024	EPA	EJ	Recommendations on Meaningful Engagement:The final EIS should disclose in more detail the public engagement conducted for the project,including information on outreach methods, attendance at meetings and efforts toaccommodate barriers such as providing meetings in locations near communities with EJconcerns, information in simple and easy to understand language, materials in languages other than English, virtual meetings, and use of non -virtual participation in areas with limited broadband access.	Concure, additional information has been included in the EIS (EJ sections). Meetings in July 2024 were held in Rolling Fork, MS, an area of EJ concern.
436	8/27/2024	EPA	EJ	Recommendations on Meaningful Engagement: The final EIS should clearly identify and describe preferences and concerns for proposed alternatives and mitigation measures from communities with EJ concerns. If communities with EJ concerns have not been meaningfully engaged regarding concerns, additional outreach should be performed to ensure the impacted communities are meaningfully engaged throughout the NEPA process. Further, the final EIS and ROD should describe how the EIS weighed community preferences and concerns in deciding on the selected alternative and mitigation measures.	Concur, language discussing that comments received during the 7 mtgs held in July 2024 which was an overwhelming support for Alt 2 have been added to the EIS. Addtionally, two EJ outreach mtgs will be held after the EIS is finalized, but before PED to inform residents about the project, adverse disproportionate impacts, and to identify mtigiation measures. See response to comment 434.
437	8/27/2024	EPA	EJ	Recommendations on Meaningful Engagement:The draft EIS states that a literature and records review of the National Register of Historic Places, State records, and historic photographs was completed to identify cultural resources (page 69). However, the draft EIS does not mention whether community input was solicited to help identify culturally significant places not listed in historical records. In addition to requesting community feedback on culturally significant places and ground truthing the information gathered during research, community input would also be important to determine the best mitigation measures for the impacts to these resources. The final EIS should identify mitigation measures, including those for community cohesion, if culturally significant resources are identified in the project area.	Concur. The EIS has been updated for clarity. In the previous Section 106 PA, one of the USACE commitments/stipulations concerned development of a Heritage Study of the general study area, taking into account the cultural and historical context of the region, acknowledging the area's cultural/historical landscape, and developing a recent study to better assess, characterize, and identify cultural resources as well as to assist in development of cultural mitigation measures. We received the draft of this effort on May 28, 2024, being circulated to all consulting parties. MS SHPO provided the only comments, stating that it satisfied the stipulations of the PA (dated July 12, 2024). Additional community involvement and participation opportunities regarding cultural/historical resources significance and potential mitigation measures has also been included in the latest draft of the amended Section 106 PA that will be distributed to consulting parties this afternoon (August 30, 2024). Additionally, USACE initiated ongoing consultation engagements with consulting partners to amend the Section 106 Programmatic Agreement developed in association with the 2020/2021 Yazoo Backwater SEIS II and in compliance with Section 106 of the NHPA through a series of electronic communications on July 3, 25, 30, and August 2, 2024. A virtual meeting was held August 7, 2024, in association with these ongoing efforts and supplemented with additional communications to all consulting parties on August 30, 2024. This amended agreement will be incorporated into the Record of Decision (ROD) in support of NEPA compliance documentation for this project and will be provided as an attachment to Appendix F-1. The initial draft was provided with the DEIS and supplemented with a revised draft circulated to all consulting parties on August 30, 2024. "
438	8/27/2024	EPA	Air Quality	Section 4.2.1.8 contains many vague and incorrect statements about air quality. The final EIS should quantify the potential air emissions and discuss the project's emissions in the context of the NAAQS, including construction and operation emissions of any criteria and hazardous air pollutants emitted by the project.	Concur. Additional information has been added for clarity.
439	8/27/2024	EPA	Air Quality	Section 4.2.1.8.1 should explain the purpose and use of social cost of carbon calculations and clarify the statements about the significance of individual greenhouse gases. For example, the second to last sentence in the section states that "CO2 is the primary contributor to GHG and climate change, followed by CH4 and N20" but does not include discussion of the global warming potential of different GHGs or fully explain that emissions of any GHG contribute to climate change. Moreover, sources of methane omit the potential sources in the project, and the abbreviation of nitrous oxide incorrectly uses a zero instead of a letter O.	Concur. Explanations of the social cost of greenhouse gasses has been included.
440	8/27/2024	EPA	Air Quality	On page 127, the draft EIS states that "implementation of Alternative 2 would not interfere with the region's ability to maintain compliance with National Ambient Air Quality Standards for attainment area pollutants and would not interfere with the ability to achieve compliance for pollutants that contribute to ozone nonattainment." Section 5.1.8 should justify this statement along with the claims of insignificant air quality impacts with actual emissions data and modeling and comparison to air quality standards, if appropriate.	Comment noted. Emission estimate tables have been included in Section 5 Air Quality analysis.
441	8/27/2024	EPA	Economics	To fully inform the USACE's public interest review, the final EIS should include information regarding the costs and benefits of each action alternative, including compensatory mitigation and each of the monitoring and adaptive management studies. Information about the potential costs of each alternative as well as the costs associated with current levels of flood damage in the YSA are important for the USACE in determining whether the project is in the public interest.	See response to comment 8
442	8/27/2024	EPA	Pump Operations	The final EIS should include information that identifies the roads that would remain inundated by backwater flooding below 90 and 93 feet. A transportation analysis should be included in the final EIS that identifies structures that could be isolated by flooded roads during these events. The analysis may include a summary of the miles of roads, major highways impacted, and maps showing the YSA and impacted neighborhoods.	Concur, a transportation section has been added to the EIS.
443	8/27/2024	EPA	Pump Operations	During previous backwater flood events, there were reports of increased use of the levee roads. These levees were not designed for high traffic volume, and overuse could present safety risks (e.g., collisions, levee road erosion, etc.). A collaboration with the Federal Emergency Management Agency and Mississippi Department of Transportation should be established to identify critical transportation routes that would benefit from floodproofing measures (e.g., elevating roads, reestablishing bridges). Such areas may include alternative routes to grocery stores, hospitals, schools, major highways, etc. that could simultaneously reduce drivers on the levee roads. The final EIS should include this analysis for public transparency and safety.	Concur, USACE works with MDOT, MEMA, and the local emergency management offices during flood events. The public did not use the backwater levee, police were located at the entrance to the levee which is gated and not many people have a key, although the levee was used for school buses and emergency personnel. The general public went along state highways around the backwater flooded area. A transportation section has been added to the EIS.
444	8/27/2024	EPA	Mitigation	To inform and support LEPDA identification in the final EIS, the final EIS should include morecomplete information on the potential human and environmental impacts and benefitsassociated with each alternative.	Comment noted and document updated.
445	8/27/2024	EPA	Mitigation	Prior to the issuance of the Record of Decision for the project, compensatory mitigation plansconsistent with 33 CFR 332.4(c) [40 CFR 230.94(c)] must be approved by the USACE. Tofacilitate public and interagency review of these plans, Appendix J of the final EIS shouldinclude as much detail as practicable regarding the elements of a mitigation plan required by33 CFR 332.4(c) [40 CFR 230.94(c)].	Comment noted. Plan documented has been approved.
446	8/27/2024	EPA	Mitigation	Appendix J (Compensatory Mitigation Plan) should include a short summary of three MOAsdescribed in Section 3 to clarify collaborative roles and to how the Compensatory MitigationMOA would build upon the final EIS.	Concur, document has been revised to incoporate.
447	8/27/2024	EPA	Mitigation	The final EIS should include a summary of potential impacts and required mitigationassociated with each alternative, not just Alternative 2 (Appendix J, Table 3). These areneeded to support the 404(b)(1) analysis, which then drives mitigation planning forunavoidable environmental impacts. As currently written, the document appears pre-decisional as it only discusses the maximum potential mitigation required but does notcharacterize it as such (e.g., Appendix J, pages 31, 39-40, and 44).	Comment noted.
448	8/27/2024	EPA	Mitigation	The final EIS should include a statement of the number of functional offsets that would be provided by each compensatory mitigation strategy.	Comment noted and incorporated into the annex

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449	8/27/2024	EPA	Mitigation	Figure 2 (Appendix J) depicts land use in the YSA, not the extent of wetlands in the YSA. The final EIS should include a figure description that cites the data source used for this map. Additionally, page 15 states, "For example, as discussed below, riverine backwater wetlands have been mapped across the LMRAV (Figure 2 below) and provide habitat for similar communities of fish and wildlife species." This sentence should be deleted or clarified such that it does not refer to Figure 2 as showing mapped riverine backwater wetlands.	Comment noted. Cited and removed
450	8/27/2024	EPA	Mitigation	Section 6.1 (Appendix J) lists a number of GIS data layers that were used in planning. This section should include titles and dates of sources used, using citations to publicly available data where possible, and ensure that information referenced can be made available in the final EIS or on the project website if it is not publicly available elsewhere (e.g., inundation maps of the post-project floodplain).	Comment noted
451	8/27/2024	EPA	Mitigation	Section 6.1 (Appendix J) introduces some site prioritization criteria but does not describe why they are important or how they will be used. Please provide an explanation to clearly document decision-making.	Comment noted. Described in measures.
452	8/27/2024	EPA	Mitigation	Figure 6 (Appendix J, page 32) introduces potential project-specific site locations near the 93- and 90-foot crop season boundaries. Please note that these elevations are the crop season boundaries for which the project is being managed, which are near the current estimated, pre-project, 2-year and 5-year floodplains. This Figure should be clarified to be consistent with the narrative throughout Appendix J, which states that compensatory mitigation sites would be located within the post-project, 2-year and 5-year floodplains.	Comment noted and captions updated.
453	8/27/2024	EPA	Mitigation	Section 10.2 (Appendix J) further discusses project-specific mitigation. For any project-specific mitigation plans that would be implemented by the USACE, the site-specific mitigation plans should be provided in the final EIS that address the 12 components outlined in the Rule at 40 CFR Subpart J. One of these components requires a long-term management plan, which details site protection and management that is envisioned to be perpetual; for consistency with the Rule, please remove any language from the final EIS that suggests the USACE has no further responsibility for its compensatory mitigation sites after a 50-year project life (e.g., pages 41, 48, 52-54, and 62).	Comment noted. The format of the appendix has been re-worked to address this.
454	8/27/2024	EPA	Mitigation	Section 13.3 (Appendix J, page 57) discusses certain scenarios where water levels could be managed to support wetland hydrology in times of drought. Because there are no proposed changes to this water level management feature, and because the topic of this appendix is related to compensatory mitigation, please remove this discussion from Appendix J.	Comment noted and removed
455	8/27/2024	EPA	Mitigation	The draft EIS also includes a discussion regarding the status of the USACE's efforts to address compensatory mitigation requirements associated with its completed MR&T projects in the YSA and Yazoo Backwater Area. The draft EIS notes that the total scope and status of the USACE's mitigation backlog to address impacts that were completed in the 1970s and 1980s will be provided in the final EIS. The final EIS must fully account for and provide firm commitments to expedite addressing its mitigation backlog in the YSA.	Thank you for your comment on our draft EIS. We recognize the importance of addressing the compensatory mitigation requirements associated with past MR&T projects in the Yazoo Backwater Area. The final EIS will provide an overview of the rocky bayou mitigation backlog and outline our commitments to expedite these efforts. We appreciate your engagement as we work towards effective solutions that benefit the community and the environment.
456	8/27/2024	Audubon Society	General Opposition	local government, professional, faith-based, and recreation organizations and businesses urgently ask you to protect the hemispherically significant wetlands in the Yazoo Backwater Area of Mississippi by enforcing your agency's long-standing Clean Water Act 404(c) veto protecting this area. These exceptional wetlands are once again at risk from the U.S. Army Corps of Engineers' (Corps) proposed Yazoo Backwater Pumping plant—an agricultural drainage project being promoted as flood control. Many of us joined with more than 130 conservation and social justice organizations and dozens of community members to call on the Corps to abandon the Yazoo Pumps during the scoping phase for this latest proposal. We urged the Corps to instead deploy effective, environmentally sustainable non-structural, natural, and nature-based flood risk reduction measures that would benefit communities and wildlife.1,2 But the Corps continues to pursue its plan3 to build the largest pumping plant in the world to benefit industrial-scale agriculture on marginal lands that have always flooded. The water drained by these massive 25,000 cubic-feet-per-second pumps, up to 16 billion gallons a day, will be pushed into an already flooded Yazoo River, increasing flood risks for highly vulnerable downstream communities that suffer from pervasive and systemic environmental injustices. This version of the Yazoo Pumps would damage 89,800 to more than 93,300 acres5 of vital wetlands—an area of wetlands twice as large as Washington, D.C., and ten times larger than the area of wetlands protected by all other 404(c) vetoed projects combined. Your agency has already determined that this plan would cause unacceptable impacts to "some of the richest wetland and aquatic resources in the nation" including vital bottomland hardwood wetlands that have long been recognized as being "among the Nation's most important wetlands." 6 These impacts are all the more unacceptable in light of the nation's alarming increase in wetland losses7 and the Supreme Court's 2023 decision in Sackett v. Army Corps of Engineers that has left millions of acres of wetlands without Clean Water Act protection. Fortunately, the Corps' latest plan is explicitly barred by your agency's long-standing veto, which prohibits "alterations to the spatial extent, depth, frequency, and duration of inundation of wetlands" that "would significantly degrade the critical ecological functions provided by approximately 28,400 to 67,000 acres of wetlands . . . in the Yazoo Backwater Area, including those functions that support wildlife and fisheries resources."8 The veto further confirms that more extensive ecological impacts would also be unacceptable. Under your leadership, EPA wisely reasserted this scientifically based veto in November 2021 to protect the region's wetlands from the Corps' attempt to resurrect the Yazoo Pumps under the previous administration.10 This important decision to enforce the veto opened the door for deploying demonstrably effective natural, nature-based and non-structural solutions for the Yazoo backwater Area that would reduce flood risks for vulnerable communities while protecting and restoring the region's hemispherically significant wetlands and making it more resilient to climate change. Your agency along with local community leaders, the conservation community, hundreds of scientists, the U.S. Fish and Wildlife Service, and others have repeatedly asked the Corps to deploy these types of commonsense solutions for the Yazoo Backwater Area.Instead of working to deploy these solutions through a whole of government approach, the Corps has once again recommended a massive pumping plant that will damage wetlands at a scale that this nation cannot afford. Our organizations call on you to prevent this from happening by enforcing the 2008 Clean Water Act 404(c) veto of the Yazoo Pumps.	EPA implements CWA section 404(c) and issued the 2008 section 404(c) Final Determination concerning the Yazoo Backwater Area Pumps Project. USACE therefore cannot speak to the applicability of EPA's Final Determination. See response to comment 5.

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457	8/27/2024	General Public	General Opposition	I urge you to withdraw your effort to revive the environmentally catastrophic, grotesquely wasteful 'Yazoo Area Pumps Pniject' in Mississippi. No amount of NEPA hand waving can alter the dispositive, fatal errors of both fact and morality in the conceptual premises of the Yazoo Project. This project has lingered as a pet dream of major agricultural interests in Mississippi for decades, has been rightly and repeatedly rejected by the Army Corps and Engineers and the Environmental Protection Agency, including under the Bush Administration, because it would drain and eradicate 200,000 acres of the country's most precious wetlands in the watershed of Mississippi's Big Sunflower River. No facts have changed to warrant the Corps' attempt to evade or suborn this veto. Rather than accept the implication of this fact, the Corps now seeks to subvert and disappear the long-established Clean Water Act review process for federal projects, nullify the considered judgment of agency scientists, and impose this gross caricature of home-state pork through raw political power. This represents an explicit demand for the liquidation of one of America's irreplaceable biological Edens, in exchange for barren, vacant land to produce low-value commodity crops. 200,000 acres of swamps, bayous, marshes, and bottomland forests will vanish, making a blatant mockery of repeated American commitments to staunch the loss of our wetlands. A more profane theft against our children and our Planet Earth, for the most venal, parochial, selfish of reasons could not be fathomed. The Environmental Protection Agency vetoed the Yazoo project in 2008, owing to the outlandish and gratuitous ecological destruction it would cause, and the utter lack of any public interest in constructing one of the world's largest water pumping complexes in a sparsely populated region. The Yazoo pumps would constitute a $300 million engineering subsidy to help landowners violently remake the landscape of Mississippi to their agricultural convenience. The pumps' sole purpose is to move up to six gallons of water per minute from one side to another of a Corps' flood control structure, to assist a handful of large landowners to increase production on lands that naturally, regularly flood and arc inappropriate for agriculture. This area already receives several million dollars federal subsidies annually, the highest payouts in Mississippi, due to regular flooding. The Yazoo pumps represent a resurrection of a bygone era in hydrological engineering, deploying overwhelming force against the natural cycles, contours, and dynamics of the Earth's life support system. The wetlands that will cease to exist include jewels of the Delta National Forest and four National Wildlife Refuges in Mississippi, which the American people have invested dearly to protect for decades. More than 450 species offish and wildlife, including 257 species of birds, rely on the wetlands to be drained by the Yazoo pumps. The public interest in maintaining these wetlands, and the right of the plants and animals to retain their homes in these wetlands, supersedes the avaricious, petty interests of agricultural interests in claiming a publicly subsidized production zone. These verdant, vibrant remnants of America's biological heritage defy any financial tabulation, and to deny our children the Big Sunflower River wetlands, as their rightful inheritance, would be a moral crime beyond any redemption for the Corps. It would serve no purpose but to surrender more fragile floodplains to production of more of the commodity crops from which America is already suffering a gross overproduction, and for which USDA already pays millions to render economically viable. Rather than spend $300 million on crude, brittle, sprawling water engineering that would be only marginally effective by the Corps' own admission, the federal government could compensate agricultural landowners by a similar amount to fallow their inappropriately located cultivation, and allow this flood-prone land to return to marshes and forests. This would fully eliminate financial risk for the relevant farmers, immensely benefit the wetland ecosystem species that have already lost so much Mississippi River wetlands, and restore wetland functions of absorption and storage iliat will mitigate risk to remaining landowners. The superiority of a natural restoration alternative to the Yazoo pumps fiasco is obvious by every metric, and should have concluded the NEPA process years ago. Again, I urge you withdraw this effort to resurrect this ecological, moral, and fiscal travesty known as the 'Yazoo Arca Pumps Project,' and accept the prior EPA veto, whose warrant has only increased since 2008,as wetlands have continued to retreat across America before human consumption. The project exemplifies the very worst of parochial engineering on behalf of narrow agricultural interests, rendering ilie Corps a private engineering service to subsidized floodplain farmers. The selfish, parochial demands of the Mississippi delegation are to be expected from politicians advocating their wealthiest constituents' expropriation of public resources, but bear no relevance to your consideration of the American public interest.	EPA implements CWA section 404(c) and issued the 2008 section 404(c) Final Determination concerning the Yazoo Backwater Area Pumps Project. USACE therefore cannot speak to the applicability of EPA's Final Determination. See response to comment 5.

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458	8/27/2024	Board of Mississippi Levee Comissioners	Alternatives	The Mississippi Levee Board wants to thank the U.S. Army Corps of Engineers (Corps), the Environmentai Protection Agency (EPA), and the U.S. Fish & Wildlife Service (USFWS) for working together to come up with a solution for our Backwater Flooding problem! We prefer Alternative 2 with a 25,000 cfs Pumping Plant that turns on at 90' starting March 16th each year. Both Alternatives 2 and 3 will protect people, homes, roads, farms, infrastructure, wildlife, fish, trees and the environment. The Federal Family of the Corps, EPA and USFWS have worked together to develop this brand new project for the South Delta. This project is compliant with the Clean Water Act and meets the needs of the community. Alternative 1 is no action, do nothing, in other words keep letting the area flood. This Alternative 1 has absolutely no support! We have been living with the "do nothing" plan for 83 years and we have seen the devastation to the economy, infrastructure, homes, lives, crops, wildlife, trees and the environment. Alternative 1 is not an option! Alternative 4 is the nonstructural only plan. This Alternative 4 has no local support. Another problem with this Alternative 4 is that is only takes care of structures and land that was flooded in 2019. In 2019 the backwater reached 98.2'. This is the 35-year flood. The 100-year flood is 100.5'. At a minimum this Alternative 4 should take care of all the structures and land in the 100-year flood- not a 35-year flood. The major objection to Alternative 4 or any other fully nonstructural plan is that it does nothing to protect the wildlife, trees and environment. These resources will continue to die and theeco-system will further decline with a nonstructural alternative. There are several national environmental groups that have historically opposed the project and have created a "click and send" form letter email that goes directly to the Corps. They use a short introduction overview full of misleading information to incite their members and they encourage them to "click and send" these emails to oppose the pumps and support the nonstructural Alternative 4. They will send tens of thousands of mass emails to the Corps. Please note that these emails will come from all over the United States and that these people do not know the facts and they have no idea where the Yazoo Backwater Area is located. Please dismiss these emails as a mass campaign to sabotage the Pumps. Alternative 4 is not an option! During the Virtual Public Meeting held July I 6th there were IQ.comments in the chat box - all IO supported the 25,000 cfs pump and all IO specifically wanted Alternative 2. During the Public Meetings held in Rolling Fork, MS on July 22nd there were 35 people who made statements. All 35 supported the pump and 24 specifically wanted Alternative 2. During the Public Meetings held in Vicksburg, MS on July 23n1 there were 34 people who made statements. All 34 supported the pump and 28 specifically wanted Alternative 2. When you total up all these statements you had 79 people who made statements. All 79 supported the pump and 62 specifically wanted Alternative 2. During the virtual meeting and all the public meetings the support for the 25,000 cfs Pump was unanimous! The local community wants the 25,000 cfs pump that will protect to 90' during the crop season and 93' during the non-crop season. Alternative 2 and Alternative 3 are the only options! We prefer the earlier turn-on date of March 16th because we have an agricultural-based economy here in the Mississippi South Delta. Even if you are not a farmer, a lot of jobs and businesses in this area depend on farming to make a living. But we also understand that in the past 46 years the pumps would have only cut on before March 25th 6 times to maintain 90' (I 994, I 997, 2016, 2018, 2019 & 2020). That averages to be only once in every 7 years. Historically, the vast majority of backwater floods reaching 90' happen in the April/May timeframe We want to change "mandatory" acquisition of all structures (101 structures) below 90' to "voluntary" acquisition. I can't believe there is anyone living in a house below 90' - especially when we have seen 90' 22 times since 1979. Also we reached 95.2' or higher 3 years in a row in 2018, 2019 & 2020! But if there is anyone living in a house below 90' then give them an option to buy them out or let them stay and help protect them. This project is an Environmental Justice project! 71% of the population is minority and 30% live below the poverty line. This project will help our minority and impoverished community. The Steele Bayou Drainage Structure was completed in 1969 and is now 55 years old. The top of the Steele Bayou Structure curtain wall is 108.5' ms!. In the next few years we will be raising the Yazoo Backwater (YBW) Levee up from 107' ms!. The authorized grade for the YBW Levee is 112.8' msl. Since the Steele Bayou Structure is older than 50 years and modifications will have to be made to it when we raise the YBW Levee we request that the superstructure being built for the 25,000 cfs Pumping Plant includes a gravity flow drainage structure capable of passing 50,000 cfs and is built above 112.8' msl. We request that the Final EIS contain all the data and results of the Recommended Plan going forward. For instance, the current I 00-year flood for the area is 100.5' and with the implementation of the 25,000 cfs pump it will drop the 100-year flood to 93.5'. This is very relevant data that shows the real and direct positive impacts of the Recommended Plan. Most people looking at a 1,000 page EIS usually only read the Executive Summary found in the beginning of the document. We found the Draft EIS Executive Summary to be lacking. In fact, we found that the Draft EIS Conclusion (Section 9) located at the very end of the Main Report to be more helpful than the Executive Summary! Knowing that 99% of the population will only look at the Executive Summary in the Final EIS we ask that you do a good job in briefly and clearly explaining the details of the Recommended Plan. Please include the mitigation requirements and list the impacts, pertinent facts and data in this Final EIS Executive Summary. The Mississippi Levee Board appreciates this Draft EIS and we look forward to the Final EIS and the signing of the Record of Decision. This project is the result of a promise made by the Federal Government 83 years ago in 1941. Please move forward with completing the Environmental Documentation so we can start construction as soon as possible so we can Finish the Pumps!	See response to comment 1

Comment Number	Comment Date	Org.	Theme	Comment	Response
459	8/27/2024	General Public	General support	I'd like to thank you and your team for working tirelessly on the subject project. I attended the virtual public meeting on July 16, 2024, all three (3) public meetings in Rolling Fork on July 22, 2024, and all three (3) public meetings in Vicksburg on July 23, 2024. I thought all seven (7) meetings went great and I really appreciate the interagency collaboration between USACE, USEPA and USFWS. I would love to see an earlier pump-on date and lower drawdown elevation, but after reviewing the final array, I'm in favor of Alternative 2 as it offers the most protection for myself and my neighbors I was raised in Issaquena County and went to Sharkey-Issaquena Academy in Rolling Fork, MS. currently live on Herman Road in Grace, MS. It is obvious that without pumps our community cannot attract industry and without industry our population will continue to diminish. As a lifelong resident of the Delta, I have seen so many friends leave our area. I had 31 students in my kindergarten class, but in 2003 I graduated with only 14 classmates because more than half had moved away. This trend did not stop when I graduated 21 years ago - Our local Deer Creek Pilot newspaper recently had "SIA will open, no sports" in big bold print across the front page. If you were to read the paper you would quickly realize there are no sports because there are not enough students. The article quotes Head of School Mrs. Sadie Hester "the school currently has four (4) seniors enrolled, a few juniors, and a few seventh graders. There are no students enrolled in the eighth, ninth or tenth grades". I am sure a lot of today's lack of students is attributed to the EF4 tornado that stormed through our troubled community last year, but I can only imagine how different things would be if those pumps that were promised some 83 years ago were in-place. A few years ago, I purchased 120 acres of hunting land that is located on the banks of Steele Bayou in Issaquena County. This land has been in my dad's family for nearly 35 years and has never experienced flooding as it did in 2019. My land is nearly 40 Miles upstream of the Steele Bayou Structure and still experienced excessive long-term overbank flooding in 2019! Unlike the project opponents, I have seen the damage that was caused to the wildlife and trees firsthand - and contrary to what those same project opponents say, I am NOT a farmer and the pumps will definitely benefit me. Today, nearly every time I try to drive the roads through my property, I must clear fallen hardwood trees that have died as a direct result of the backwater floods we experienced 5 to 6 years ago. These floods also caused erosions and excessive damage to culverts and other drainage structures on my property. Not only did the backwater push out or kill the wildlife on my land, it also left behind deposits of old plastic bottles, old coolers, old herbicide containers and other unwanted debris. As the 2019 backwater receded from several months of overbank flooding, it also caused widespread bank sloughing along the interior streams. This was not just on my land, it's throughout the entire backwater area. You can see it on the Big Sunflower River, the Little Sunflower River, Steele Bayou, and many other interior drainage ditches. I know I have personally seen it while driving through Holly Bluff, Grace, Delta City, Eagle Lake, Onward and I'm quite certain it can be found elsewhere. The sediment and silt bars that deposited because of banks sloughing off only compounded the drainage issues we already had in our area - as most of the interior streams were already lacking much needed maintenance because they have not seen a major Corps of Engineers cleanout/dredge project in over 65 years. Unlike nonresident project opponents, I truly love this place that I call home and would love to see the 25,000 cfs pump station in Alternative 2 constructed. This would help protect the trees, the wildlife, the environment, and most importantly my family, friends, and neighbors and each of our lifelong investments we have worked so hard to protect. I'm asking you to please give us the help we so desperately need and deserve! Thanks again and please feel free to contact me to look at any of the issues I have mentioned in this letter - I would be happy to show anyone around.	See response to comments 1, 39, 45, 67, 90, 91, 113, and 503
460	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	Aquatics	The Yazoo Pumps Alternatives are also prohibited by the Clean Water Act veto because each will have a pumps-on elevation of 91-feet during seven critical months each year—spring migration, breeding seasons, and fall migration. The Clean Water Act veto prohibits a range of operating plans, including a 14,000 cfs pumping plant with a pump-on elevation of 91-feet, including because of the unacceptable impacts of operating below this elevation "during the critical spawning and reading months" in early spring and summer.6	EPA implements CWA section 404(c) and issued the 2008 section 404(c) Final Determination concerning the Yazoo Backwater Area Pumps Project. USACE therefore cannot speak to the applicability of EPA's Final Determination. See response to comment 5.

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461	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	Aquatics	E. The DEIS Dramatically Understates Impacts to the Hundreds of Fish and Wildlife Species that Rely on the Yazoo Backwater Area's Wetlands The DEIS dramatically understates impacts to the hundreds of species of fish and wildlife that rely on the Yazoo Backwater Area's vital wetlands. The actual impacts from the Yazoo Pumps Alternatives will be much greater than acknowledged in the DEIS, including because the DEIS fails to carry out any assessment at all of extensive array of impacts to fish and wildlife. This is an egregious failing given the importance of the Yazoo Backwater Area's ecologically rich wetlands to more than 450 species of birds, fish, and wildlife. Located in the heart of the Mississippi River flyway, the Yazoo Backwater Area is especially important to migratory species, many of which are already experiencing alarming population declines.123 Sixty percent of all North American bird species and 40% of North America's waterfowl migrate through the Mississippi River flyway. For example: • As documented by the National Audubon Society,2 the Yazoo Backwater Area is used by 29 million migrating birds each year. More than 18 million birds migrate through the area each year during fall migration, and more than 10 million birds migrate through the area each year during spring migration. More than 6.3 million birds from 17 different overwintering species use the Yazoo Backwater Area from December through February. • The Yazoo Backwater Area supports a highly productive floodplain fishery that includes at least 95 different species, if not more.124 Of these, the U.S. Fish and Wildlife Service estimates that over 58 species depend on backwater flooding and access to the floodplain to fulfill numerous life history requirements.125 • The Yazoo Backwater Area is home to a number of at-risk species and species of special concern, including species designated as threatened or endangered under the Federal Endangered Species Act.EPA issued the 2008 Clean Water Act veto because the Yazoo Pumps "would result in unacceptable adverse effects on fishery areas and wildlife," highlighting the loss of spring flood pulses as of particular concern as those coincide with and support key lifecycles of fish and wildlife. Indeed, the veto "is based solely on environmental harms to fisheries and wildlife in the Yazoo Backwater Area" as "is appropriate given the structure and language of the CWA and case law."126 In the veto, EPA also noted that the U.S. Fish and Wildlife Service "concurred with EPA's conclusion that the Yazoo Backwater Area Project would result in significant degradation and unacceptable adverse effects on wildlife and fisheries resources" and expressed appreciation for the veto acknowledging "the full breadth of the proposed project's anticipated adverse impacts to its four National Wildlife Refuges located within the project area."127 Accordingly, it is critical that the DEIS comprehensively examine and document the direct, indirect, and cumulative impacts of the Yazoo Pumps Alternatives and other alternatives on the full array of species that rely on the Yazoo Backwater Area, including fish, waterfowl, birds, mammals, reptiles, amphibians, and mussels. Close attention must be paid to at-risk species, including species listed under the Endangered Species Act and candidate species thereof, and species included in the Mississippi State Wildlife Action Plan.128 The EIS also must comply with the consultation and other requirements of the Endangered Species Act and the requirements of the Fish and Wildlife Coordination Act. To properly assess impacts to fish and wildlife, the Corps must use transparent and scientifically justified approaches. Critically, the Corps must first comprehensively evaluate the impacts of the project on the wetlands, streams, and conservation lands in the Yazoo Backwater Area. This evaluation must carefully account for the extent, timing, and duration of overbank flooding and resulting changes to water quality and quantity. Once baseline habitat losses and their ecological implications are determined, the implications of those changes must be assessed for the wildlife species that rely on the affected habitats. The Corps also must examine and document the impacts to fish and other aquatic species resulting from becoming entrained in the proposed 25,000 cfs pumps and/or from becoming stranded in the floodplain because of operation of the Yazoo Pumps Alternatives. The DEIS also should, but does not, take advantage of the expertise of the U.S. Fish and Wildlife Service. Instead, the Corps opted to release the DEIS without having had the benefit of evaluating and considering the Services' views as expressed in the legally required Fish and Wildlife Coordination Act Report. Because the Fish and Wildlife Coordination Act Report is not included in the DEIS, the public also does not have the benefit of the Service's input to assist the public's evaluation of the DEIS's assessment of fish and wildlife impacts. The assessment of habitat losses must include a careful evaluation of those changes that are significant for fish and wildlife, including wetland losses, loss or modification of wetland functions, and loss of natural flood pulses in the Yazoo Backwater Area. For example:Disruption of lateral connectivity and the flood pulse can affect both aquatic and non-aquatic organisms, as well as nutrient processing, and other floodplain functions (Cobb et al. 1993, Lytle and Poff 2006 and references therein). For example, productivity of songbirds and waterfowl can be affected because of the influence of the flood pulse on predators and food availability (Heitmeyer 2006, Hoover 2006, Cooper et al. 2009, Hoover 2009). Furthermore, channelization and dams can alter the timing, depth, duration, and frequency of floods and disrupt synchronized linkages between the flood pulse and life history processes of organisms (Richter et al. 1997, Bunn and Arthington 2002, Heitmeyer 2006, Hupp et al. 2009). * * * Floodplain forests historically provided a variety of habitats for breeding amphibians, secretive marsh birds, and wintering and breeding waterfowl. Furthermore the diversity of hydroperiods resulted in abundant aquatic invertebrate populations and high seed production by moist-soil plants. These food and structural resources are critical for fulfilling wintering, breeding, and migrating waterfowl and shorebird needs; however, they have been lost over broad expanses of the landscape as a result of widespread drainage. Such resources are not restored through simple planting of trees.129 The 2008 Clean Water Act veto (including its Technical Appendices) provided detailed information on the many species that rely on the Yazoo Backwater Area, discussed vital habitat needs for those species, and highlighted the harm that the Yazoo Pumps would cause to those species. These documents should form the foundation of the assessment of fish and wildlife impacts in the EIS. The overwhelming majority of wildlife species in the South Delta are well-adapted to living and thriving in floodplain environments and rely on wetlands sustained by flooding for critical phases of their life cycles (including ducks, migratory songbirds, wading birds, raptors, snakes, frogs, salamanders, alligators to name a few). The tens of thousands of acres of damage to these vital wetlands that would be caused by the Yazoo Pumps Alternatives—and the elimination of spawning habitat caused by loss or reduction of overbank flooding—cannot be offset by rare large-scale flood events.130 The impacts to fish and wildlife must be assessed in light of an understanding of current population levels, existing stressors, and full life cycle needs of the species that utilize the project area. Lifecycle needs include such things as: fish spawning (including the timing, amount, and depth of overbaflooding needed to trigger spawning), fish rearing, fish refugia; breeding, rearing, resting, and feeding for all species; and for migratory species the availability of food and stopover habitat throughout their migratory cycles. The Corps must fully assess and account for impacts that prevent fish and wildlife from accessing the right habitats and food supplies at the times of the year (and for the right amount of time) needed to support these critical lifecycle needs. To do this, the Corps must ensure that it is not masking or understating the adverse impacts of the Yazoo Pumps Alternatives, including by relying on such things as annual, seasonal, and monthly averages of impacts to assess habitat losses, or failing to assess impacts to species with different or more specialized habitat and food source needs. A careful and robust assessment of these needs is critically important for understanding the true extent of adverse impacts to fish and wildlife because the Yazoo Pumps Alternatives will keep water levels at extremely low elevations during the time periods that are most critical for migration, breeding, spawning, and rearing to benefit industrial-scale agriculture: • Alternative 2 would damage at least 93,306 acres of wetlands by keeping water levels at or below the 90-foot elevation—the 2-year floodplain—throughout the migration, breeding, spawning and rearing breeding periods. Alternative 2 would keep water levels at or below the 90-foot elevation from March 16 through October 15 (214 days or 7 months) • Alternative 3 would damage at least 89,839 acres of wetlands by keeping water levels at or below the 90-foot elevation—the 2-year floodplain—throughout the migration, breeding, spawning, and rearing periods. Alternative 3 would keep water levels at or below the 90-foot elevation from March 25 through October 15 (205 days or 6 months and 21 days). Critical problems with the DEIS assessment of fish and wildlife impacts are discussed	See respose to comment 5

Comment Number	Comment Date	Org.	Theme	Comment	Response
462	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	Aquatics	G. The DEIS Understates Impacts to Fisheries The DEIS understates impacts to fisheries and understates the amount of mitigation needed to offset those impacts. Among other problems, the EnviroFish analysis relies on modeling parameters specifically rejected by the Clean Water Act veto and masks the effect of operating the Yazoo Pumps Alternatives by assessing and then averaging impacts across the full period of record—even during the many years when the Yazoo Pumps would not have been operating. The DEIS also states that it will only implement 55% of the amount of the recommended mitigation. According to the DEIS, Alternative 2 would result in an estimated loss of "2,264 and 1,862 HUs for spawning and rearing, equivalent to a reduction of 3,969 and 3,721 Average Daily Flooded Acres, respectively. To compensate for direct and indirect impacts associate with pump implementation and operation only, 3,201 and 2,632 acres of agricultural lands would need to be reforested in the 2-year floodplain for spawning and rearing, respectively." Alternative 3 would result in similar losses and mitigation needs. However, the Compensatory Mitigation Appendix limits fisheries mitigation to a total of 3,201 acres without providing any explanation for this significant reduction. This is just 55% of the total amount of required mitigation acres acknowledged in the DEIS. includes at least 95 different species, if not more. Of these, the U.S. Fish and Wildlife Service estimates that over 58 species depend on backwater flooding and access to the floodplain to fulfill numerous life history requirements.And, of course, the Yazoo Pumps adverse impacts to fish and wildlife are the reason that EPA issued the 2008 Clean Water Act veto. Understanding the full extent of the Yazoo Pumps Alternatives on the overbank flooding regime is essential as highlighted in the 2008 Clean Water Act veto and the 2007 Fish and Wildlife Coordination Act Report. For example: • "Much of the productive potential for fisheries in floodplain river ecosystems is determined by the dynamics of overbank flooding and riparian vegetation (Jackson and Ye 2000)." • "The presence of aquatic invertebrates in the relatively warmer backwater areas encourages spawning of fishes in the inundated floodplain, and the earlier that spawning can take place the longer the fish can remain on the floodplain and the higher the recruitment potential for the rivers' fish stocks (Jackson 2005)." • "In floodplain ecosystems such as the Yazoo Backwater Area (Figure 4), flooding not only enhances fish production, but also plays a key role in maintaining genetic and species diversity (Bayley 1995, Sparks 1995). Fishes use the floodplains for spawning, feeding, and refuge habitat (Welcomme 1979, 1985, Sparks et al. 1990). During flood periods, fishes gain access to inundated forests where they feed on terrestrial arthropods, fruits, seeds, flowers, and leaves (Ye 1996)." • "Welcomme (1976, 1985, 1986), Goulding (1980), and Sparks et al. (1990) indicate that fish production in floodplain rivers is strongly influenced by the timing, height, and duration of flooding. In the lower Mississippi River and its tributaries, positive relationships between fish abundance and the acreage of bottomland hardwood forests susceptible to flooding have been documented (Risotto and Turner 1985). Bayley (1995) found that multi-species fish biomass was significantly greater in rivers with flood pulses and floodplains than in impoundments with stable water levels. Despite the unquestionable importance of the Yazoo Backwater Area to fisheries resources and the critical need to fully assess impacts to these vital fisheries, the DEIS suffers from critical flaws that will understate fisheries impacts and render the fisheries assessment fundamentally unreliable. A number of these flaws are highlighted below. First, the Aquatic Resources and Fisheries appendix sates that the EnviroFish analysis only assessed impacts within the 2-year floodplain. However, failing to assess hydrologic changes and related impacts above the 2-year floodplain was explicitly rejected by the Clean Water Act veto. According to the Appendix, the EnviroFish analysis looked at the following area: "For this application, only agriculture and bottomland hardwood cover types within the 2- year flood frequency were considered. Fallow lands were not included in ADFA calculations because they represent less than 1% of all land-cover, but were used in calculation of reforestation mitigation acres during the growth transition period." According to the Appendix, the Corps also "made certain assumptions on the application of EnviroFish to calculate ADFAs [Average Daily Flooded Acres]" including that "Flooded bottomland hardwoods in the 2-year flood frequency are the preferred spawning and rearing habitat." Since all spawning and rearing habitat above the 2-year floodplain will be lost through operation of the Yazoo Pumps Alternatives—because both will keep water from rising above the 2-year floodplain elevation throughout the spawning season—a failure to assess impacts above the 2-year floodplain would translate into a significant underestimate of fisheries impacts. In addition, in most situations fish spawning will not be restricted to the 2-year floodplain unless there are drastic habitat changes at higher elevations, a situation that does not exist in the Yazoo Backwater Area. In most cases, the habitat within the 2-year floodplain may be more preferred simply because it floods more often, and that flooding may occur at the exact optimal successional stage for fish. But it is highly unlikely that one could detect a statistical difference in fish preference/selection of the 2-yr floodplain versus the 5-yr floodplain. The Conservation Organizations have been told that the Corps claims to have assessed impacts to the 5-year floodplain (though the Corps has not made this claim to the Conservation Organizations), but we are not able to confirm that based on the extremely limited information provided in the DEIS. We also highlight that if the restricted scope of the EnviroFish impacts analysis is an error in drafting, an error of this significance raises significant questions about the accuracy of the other information provided in the DEIS and must be corrected with a detailed explanation of how the modeling accounts for impacts beyond the 2-year floodplain. Second, the EnviroFish model relied on an approach to assessing impacts to spawning habitat that was explicitly rejected by the Clean Water Act veto. The EnviroFish model restricted its assessment of spawning acres to those that had "a minimum depth of 1.0 foot and flooded for a minimum duration of 8 consecutive days. This approach was explicitly rejected by the Clean Water Act veto because it will result in a significant underestimate of impacts: The Corps stated that areas flooded one foot deep for eight days are sufficient for fish spawning. The Corps has stated that most fish species reach sexual maturity in one or two years, so a flood that occurs once every two years is necessary to maintain reproductive populations. Eight days is insufficient for any substrate spawning fish (Schramm pers. comm. 2008). Eggs take 3 to 5 days to hatch. Larval fish fry are barely able to swim the first 7 to 10 days, while the yolk sac is being absorbed. If floodwaters are drawn down in 8 days, fry would be forced to retreat to deeper channels and lake habitats where mortality rates are high. Longer periods of shallow inundation in hardwood and other vegetated areas provide critical nursery habitat for growth and escape from predators. These depth and timing requirements are critical. For example, "if the water recedes too rapidly off the floodplain, organic matter, nutrients, and newly hatched aquatic organisms may be carried into the river instead of remaining in the floodplain and permanent backwaters." Many fish species also rely on the floodplain to provide rearing habitat. For example, extended periods of shallow inundation in hardwood and other vegetated areas provide critical nursery habitat for growth and escape from predators. Accordingly, any reduction in extent or duration of inundation of flooded bottomland hardwood wetlands would reduce the fish productive capacity of the wetland. The "8 consecutive day" criterion relied upon by the Corps is at best, the amount of time needed for successful egg hatching. However, "8 consecutive days" may not even be sufficient for that, as egg development and hatching are always temperature-dependent (i.e., eggs will develop and hatch more quickly during warm temperatures and more slowly during cooler temperatures). As a result, while 8 days may be long enough for egg hatching in some (and perhaps most) years, it may not be long enough in all years. Restricting the analysis of fisheries impacts to changes that might affect egg hatching (i.e., 8 consecutive days) also runs counter to the clear acknowledgement in the EnviroFish User Manual that the full range of early life history stages must be analyzed since they are "often the limiting factor in population growth" and "inter-annual variations in flooding regime of rivers [will] affect reproductive success and year-class strength of many species"	USACE agrees with these statements on the importance of wetlands. Wetland mitigation requirements were higher than aquatic impacts, so mitigating for wetlands will fully compensate for aquatics, even beyond the Envirofish calculations. The description of landuse was corrected in the Aquatic Appendix as follows: EnviroFish uses the landuse and elevation (cleared and forested stage-area curves) flooded every foot, every day, over the period of record, during the designated spawning season with and without pump. The without pump condition is run regardless of flood elevation up to the 5-year elevation. The with-pump condition is based on the two alternatives up to the 5-year elevation. The parameters used in EnviroFish were coordinated with cooperating agencies. The spawning criteria of 8 days duration with at least 1 ft of water was used to delineate spawning habitat over the period of record with and without project. The justification and rationale were clearly explained in the EnviroFish manual. EnviroFish also considers rearing habitat that does not have hydraulic or day-duration restrictions. Once the eggs hatch, they enter the rearing life stage that includes all flooded habitat within the delineated floodplain from March-June regardless of depth. Therefore, EnviroFish's application for this project did consider the full range of early life stages. 3. Spawning criteria - The parameters used in EnviroFish were coordinated with cooperating agencies. The spawning criteria of 8 days duration with at least 1 ft of water was used to delineate spawning habitat over the period of record with and without project. The justification and rationale were clearly explained in the EnviroFish manual. EnviroFish also considers rearing habitat that does not have hydraulic or day-duration restrictions. Once the eggs hatch, they enter the rearing life stage that includes all flooded habitat within the delineated floodplain from March-June regardless of depth. Therefore, application of EnviroFish for this project did consider the full range of early life stages

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463	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	Aquatics	First, the Aquatic Resources and Fisheries appendix sates that the EnviroFish analysis only assessed impacts within the 2-year floodplain. However, failing to assess hydrologic changes and related impacts above the 2-year floodplain was explicitly rejected by the Clean Water Act veto.225 According to the Appendix, the EnviroFish analysis looked at the following area: "For this application, only agriculture and bottomland hardwood cover types within the 2- year flood frequency were considered. Fallow lands were not included in ADFA calculations because they represent less than 1% of all land-cover, but were used in calculation of reforestation mitigation acres during the growth transition period."226 According to the Appendix, the Corps also "made certain assumptions on the application of EnviroFish to calculate ADFAs [Average Daily Flooded Acres]" including that "Flooded bottomland hardwoods in the 2-year flood frequency are the preferred spawning and rearing habitat."227 Since all spawning and rearing habitat above the 2-year floodplain will be lost through operation of the Yazoo Pumps Alternatives—because both will keep water from rising above the 2-year floodplain elevation throughout the spawning season—a failure to assess impacts above the 2-year floodplain would translate into a significant underestimate of fisheries impacts. In addition, in most situations fish spawning will not be restricted to the 2-year floodplain unless there are drastic habitat changes at higher elevations, a situation that does not exist in the Yazoo Backwater Area. In most cases, the habitat within the 2-year floodplain may be more preferred simply because it floods more often, and that flooding may occur at the exact optimal successional stage for fish. But it is highly unlikely that one could detect a statistical difference in fish preference/selection of the 2-yr floodplain versus the 5-yr floodplain. The Conservation Organizations have been told that the Corps claims to have assessed impacts to the 5-year floodplain (though the Corps has not made this claim to the Conservation Organizations), but we are not able to confirm that based on the extremely limited information provided in the DEIS. We also highlight that if the restricted scope of the EnviroFish impacts analysis is an error in drafting, an error of this significance raises significant questions about the accuracy of the other information provided in the DEIS and must be corrected with a detailed explanation of how the modeling accounts for impacts beyond the 2-year floodplain. Second, the EnviroFish model relied on an approach to assessing impacts to spawning habitat that was explicitly rejected by the Clean Water Act veto. The EnviroFish model restricted its assessment of spawning acres to those that had "a minimum depth of 1.0 foot and flooded for a minimum duration of 8 consecutive days."228 This approach was explicitly rejected by the Clean Water Act veto because it will result in a significant underestimate of impacts: The Corps stated that areas flooded one foot deep for eight days are sufficient for fish spawning. The Corps has stated that most fish species reach sexual maturity in one or two years, so a flood that occurs once every two years is necessary to maintain reproductive populations. Eight daysis insufficient for any substrate spawning fish (Schramm pers. comm. 2008). Eggs take 3 to 5 days to hatch. Larval fish fry are barely able to swim the first 7 to 10 days, while the yolk sac is being absorbed. If floodwaters are drawn down in 8 days, fry would be forced to retreat to deeper channels and lake habitats where mortality rates are high. Longer periods of shallow inundation in hardwood and other vegetated areas provide critical nursery habitat for growth and escape from predators.229 These depth and timing requirements are critical. For example, "if the water recedes too rapidly off the floodplain, organic matter, nutrients, and newly hatched aquatic organisms may be carried into the river instead of remaining in the floodplain and permanent backwaters."230 Many fish species also rely on the floodplain to provide rearing habitat.231 For example, extended periods of shallow inundation in hardwood and other vegetated areas provide critical nursery habitat for growth and escape from predators. Accordingly, any reduction in extent or duration of inundation of flooded bottomland hardwood wetlands would reduce the fish productive capacity of the wetland.232 The "8 consecutive day" criterion relied upon by the Corps is at best, the amount of time needed for successful egg hatching. However, "8 consecutive days" may not even be sufficient for that, as egg development and hatching are always temperature-dependent (i.e., eggs will develop and hatch more quickly during warm temperatures and more slowly during cooler temperatures). As a result, while 8 days may be long enough for egg hatching in some (and perhaps most) years, it may not be long enough in all years.Restricting the analysis of fisheries impacts to changes that might affect egg hatching (i.e., 8 consecutive days) also runs counter to the clear acknowledgement in the EnviroFish User Manual that the full range of early life history stages must be analyzed since they are "often the limiting factor in population growth" and "inter-annual variations in flooding regime of rivers [will] affect reproductive success and year-class strength of many species"233: The reproductive cycles of most floodplain fishes are closely related to timing, spatial extent, and duration of flooding. Numerous fish species undergo regular migrations to use inundated floodplains for a variety of reproductive purposes such as spawning, short-term incubation of eggs, and eventually as nursery habitat for yolk-sac (non-feeding) larvae (Guillory 1979, Ross and Baker 1983, Finger and Stewart 1987, Copp 1989, Scott and Nielson 1989). Once the yolk-sac is absorbed, larval fish must forage in the floodplain or adjacent waterbodies for small insects and zooplankton (Lietman et al. 1991). These early life history stages are often the limiting factor in population growth, and inter-annual variations in flooding regime of rivers affect reproductive success and year-class strength of many species (Starrett 1951, Guillory 1979, Larson et al. 1981; Zeug 2005)To properly assess impacts to fisheries resources, the Corps must at a minimum assess and account for the loss of 14 consecutive days of overbank flooding to a depth of at least one foot. Third, the EnviroFish model masks the impacts of the Yazoo Pumps Alternatives by assessing and then averaging impacts across the full period of record—including during the many years when the Yazoo Pumps would not have been operating. This clearly understates the impacts of the Yazoo Pumps Alternatives, which will only operate when backwater flooding is predicted to exceed the 2-year floodplain elevation (90-feet). According to the DEIS, the EnviroFish model summarized the average daily flood acres during period from March 1 through June 30 over a 43-year period of record (1978-2020).235 However, as documented in the DEIS, the Yazoo Pumps Alternatives only would have operated during 22 of those years, or just 51% of those years.236 The Yazoo Pumps Alternatives could only prevent overbank flooding—which could critically affect the ability of fish to spawn and rear in the floodplain—when the pumps operate; they obviously have no ability (or need) to do so when they will not be operated. The DEIS should have assessed the loss of fisheries habitat both during peak flood years and during the years in the period of record when the Yazoo Pumps would have been operating. By including non-flood years—i.e., the years when the pumps would not be operating—in developing its summary of average daily flooded acres against which to assess impacts—the EnviroFish model masks the actual impacts of the Yazoo Pumps Alternatives and likely substantially understates the adverse impacts to fish spawning and rearing. For example, in 2000, the peak water elevation level at the landside Steele Bayou gage reached 77.4 feet.237 In 2019, the peak water elevation level at this same gage reached 98.23 feet.238 Relying on the average of these two years would suggest that average annual water elevations (and their related flooded acres) reach the 87.815-foot elevation. Under this scenario, the Yazoo Pumps Alternatives would never be turned on and as a result would have zero impacts on fisheries resources. The EnviroFish model compounds this already problematic averaging by its double-averaging approach. The model first calculates the average daily flooded area for a given land use and a given year of water elevations and then averages the yearly average daily flooded acres for a given land use to obtain average daily flooded acres for the entire period of analysis.239 The biotic benefits of floodplain connectivity to fish species, including during infrequent but major flood events is well recognized. For example: Overall, we have demonstrated that inundation of the Mississippi River floodplain increased species diversity, relative abundance, and growth of some dominant fish species. Thus,these biotic benefits of floodplain connectivity are extremely important to riverine fishes. However, these areas are considered one of the most imperiled ecosystems in the world (Welcomme 1979; Nilsson et al. 2005), principally owed to human activities. Thus, conservation strategies orrestoration approaches that attempt to reestablish connectivity are paramount to restoring large floodplain rivers and the associated biota worldwide. Because large floodplain rivers are prone to infrequent, major floods, restoration practitioners should anticipate such floods by creating large floodways that can be activated when necessary, thereby producing a win–win outcome of improving the ecological function of large, floodplain rivers while at the same time mitigating negative impacts of catastrophic floods on humans.240 However, the Yazoo Pumps Alternatives would significantly compromise this vital connectivity during periods that are particularly critical to riverine and floodplain fish species. To properly understand the impacts of the Yazoo Pumps Alternatives on fisheries resources, it is essential that the DEIS analyze the habitat losses that would occur during periods of higher water elevations when the pumps would be operating and then assess the implications of those losses on spawning and rearing during that year along with the cascading impacts of losses of individual year classes to future fisheries health and productivity.241 The DEIS does not provide this information, which is essential for making a reasoned choice among alternatives.	Comment Noted. Application of EnviroFish considered impacts to fisheries, and depending on the alternative, includes a complete evaluation of the 0-to-5-year floodplain with and without project. Furthermore, wetland mitigation requirements were higher than aquatic impacts, so mitigating for wetlands will fully compensate for aquatics, even beyond the Envirofish calculations. The description of landuse was corrected in the Aquatic Appendix as follows: EnviroFish uses the landuse and elevation (cleared and forested stage-area curves) flooded every foot, every day, over the period of record, during the designated spawning season with and without pump. The without pump condition is run regardless of flood elevation up to the 5-year elevation. The with-pump condition is based on the two alternatives up to the 5-year elevation. See response to comment 5.

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464	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	Aquatics	Fourth, the EnviroFish model restricted the maximum depth of rearing habitat "to 10 feet, due to low dissolved oxygen (DO) levels observed in deeper areas." This limitation, however, ignores the fact that low DO levels typically do not appear throughout the entire water column, but instead are typically seen in the lower elevations. If this EnviroFish restriction excluded all waters deeper than 10 feet as rearing habitat, it would have missed areas where rearing was still occurring in those areas above 10 feet where DO levels were not limited.	See response to comments 5, 462, and 463
465	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	Aquatics	Fifth, the EnviroFish model lacks transparency (the entire discussion of the model covers just 9 pages), making it difficult to assess the full range of the potential problems with the model. Notably, neither the DEIS nor the EnviroFish User Manual provide any information or assessment related to the margins of error, confidence limits, or sensitivity analysis applicable to the DEIS EnviroFish estimates or to EnviroFish estimates more generally. Instead of providing actual information upon which to assess the relative accuracy of the EnviroFish analysis, the DEIS presents the EnviroFish numerical data in a manner that implies a level of precision that is not justified, leading to significant overconfidence in the accuracy of the EnviroFish data (often referred to as precision bias). Notably, the DEIS does not provide the detailed information identified by EPA in 2020 as vital for understanding the EnviroFish model outputs. In its comments on the fundamentally flawed 2020 Draft EIS, EPA recommended among many other things that the: FSEIS and final 404(b)(1) Evaluation: • Provide a full description of the analysis of impacts on fish and other aquatic organisms and clarify how the values in the spawning and rearing habitat assessment were determined, including the methodology, assumptions, calculations, and uncertainties. • Identify where values changed between 2007 and 2020 analyses and clearly explain to what extent and why these changes are the result of the application of newdata/analysis, changes in the assumptions or framework of the assessment, changes in conditions on the ground, and/or other factors. • Clarify the assumptions and use of the weighting factor to reduce the loss of AAHUs in the 2020 spawning and rearing habitat impact analysis.242	See response to comments 5, 462, and 463
466	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	Aquatics	Sixth, the DEIS significantly understates the amount of mitigation needed to offset fisheries impacts. Among many other reasons: (a) The DEIS fails to assess the full array of adverse impacts to fisheries resources, including such things as the adverse impacts of intensified agricultural production, and the resulting increased use of nutrients and pesticides that ultimately will enter the rivers and streams adversely affecting water quality. (b) Despite the many problems with the EnviroFish model discussed above, the DEIS relies solely on EnviroFish model outputs to identify needed mitigation. However, the model cannot provide a precise assessment of mitigation needs (at best it can provide a prediction of biological responses to different flooding scenarios). (c) The Compensatory Mitigation Plan states that just 3,201 acres of reforestation of agricultural lands are required to mitigate fisheries impacts, even though the highly problematic EnviroFish model states that 5,833 acres of reforestation would be needed to offset direct and indirect impacts to spawning and rearing.243 As a result, the Compensatory Mitigation Plan recommends implementing just 55% of the amount of mitigation required to offset direct and indirect impacts of the Yazoo Pumps Alternatives, presumably based on the Corps' stated goal of mitigating impacts to multiple resources "within a single footprint where possible." The DEIS provides no justification for this massive reduction in acreage. Moreover, the DEIS acknowledges that reforestation of agricultural lands has not been effective in offsetting fisheries impacts: Reforestation of agricultural lands has been the primary in-kind mitigation feature of the project area. However, despite over 30 years of reforesting lands in the project area, increases in fish diversity and/or richness has not been evident since monitoring began in the 1990's. Fish diversity metrics measured in the Big Sunflower-Steele Bayou drainage are typically 20-50% lower than reference watersheds in the same ecoregion. The Compensatory Mitigation Plan also provides no justification for being able to implement all mitigation within a single footprint – which the DEIS appears to believe can be done by reforesting 7,650 acres to address all project impacts, including to wetlands, fisheries, andwaterfowl.246 This would further dilute the amount mitigation being implemented to offset fisheries impacts. As noted above, the proposed amount of mitigation to offset fisheries impacts is less than the amount of needed fisheries mitigation identified in the fundamentally flawed 2020 EIS, even though: (i) the level of fisheries impacts identified in the 2024 DEIS are significantly larger than those acknowledged in 2020; (ii) both assessments are based on the EnviroFish model; and (iii) both assessments applied the same 0.71 AAHU per acre mitigation credit for reforestation.247(d) Neither the proposed low flow wells nor operational changes to the Steele Bayou flood control structure offset fisheries impacts created by the Yazoo Pumps Alternatives. Both are designed to offset impacts from low flows, however, the Yazoo Pumps are intended to reduce high flows. Moreover, the relief wells will likely create their own set of adverse impacts and have not been demonstrated to work as claimed, as discussed in Section A and J of these comments. Because of these many failings, the mitigation that has been proposed to offset fisheries impacts is not sufficient—even if the limited amount of mitigation proposed could somehow replace all lost functions and values critical to fisheries, which it cannot.	See response to comments 5, 462, and 463
467	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	Alternatives	Both alternatives also include multiple low flow wells located outside the Yazoo Backwater Area measures and modifications to the operation of the Steele Bayou Water Control Structure, which DEIS says will reduce environmental impacts.40 However, EPA identified "extensive deficiencies regarding the installation of such wells" and rejected the addition of such wells as a basis for sidestepping the 2008 Clean Water Act veto.41 The Conservation Organizations also provided extensive, detailed comments on the inappropriateness of using such wells—including because the use of such wells are counterproductive, will not reduce environmental impacts, and cannot be used as a form of mitigation under the strict requirements applicable to the use of out-of-kind mitigation—in comments on the 2020 Yazoo Pumps DSEIS. The Conservation Organizations agree that environmental benefits would be achieved by modifying the operation of the Steele Bayou Water Control Structure to allow water levels to reach 75.0 feet in the Yazoo Backwater Area before the gates are closed42, that modification can—and should be—carried out as an independent action. That modification is not related to, and is not dependent on, construction and operation of the Yazoo Pumps Alternatives. As discussed in Section L of these comments, the significant adverse impacts of the Yazoo Pumps Alternatives will not be offset by the mitigation proposed in the DEIS and likely cannot be meaningfully offset by any amount of mitigation.	See response to comments 5, 67, and 113
468	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	Alternatives	The 404(b)(1) Guidelines prohibit a discharge unless it has been clearly demonstrated that there is no "practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem." 40 C.F.R. § 230.10(a). The Corps has not—and cannot—demonstrate that the Yazoo Pumps Alternatives are the least environmentally damaging practicable alternative. See Sections M and N of these comments. As a result, the Yazoo Pumps Alternatives are prohibited. The Corps continues to disregard practicable, less-damaging alternatives repeatedly proposed by EPA, the U.S. Fish and Wildlife Service, Yazoo Backwater Area community leaders, the conservation community, and the public. As the Corps is aware, the Conservation Organizations developed, and continue to advocate for, the use of a highly practicable Resilience Alternative in lieu of the Yazoo Pumps. This Resilience Alternative and Information for prioritizing the use of the measures included in the Resilience Alternative are provided again at Attachment A. The measures included in the Resilience Alternative are demonstrably effective and demonstrably practicable and would avoid the incredibly destructive and dangerous impacts of the Yazoo Pumps Alternatives or any other derivation of the Yazoo Pumps, as discussed in Section M of these comments	See response to commment 5
469	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	alternatives	M. The DEIS Does Not Evaluate the Highly Effective and Practicable and Resilience Alternative The DEIS fails to evaluate a highly practicable and demonstrably effective Resilience Alternative361 that has repeatedly been recommended by the Conservation Organizations. This Resilience Alternative consists of demonstrably effective and practicable measures that could be quickly implemented without causing any of the highly significant harm that would be caused by the Yazoo Pumps Alternatives. The types of measures included in the Resilience Alternative have repeatedly been called for by Yazoo Backwater Area community leaders and residents, County hazard mitigation plans, the U.S. Fish and Wildlife Service, and EPA. The Resilience Alternative utilizes sustainable solutions that are being employed by communities across the country to reduce flood risks, including purchasing wetland reserve and floodplain easements, voluntary buyouts and relocations, and flood-proofing infrastructure (including elevating homes, buildings and roads). These solutions can be carried out under existing federal programs that are currently funded and available for use in the Yazoo Backwater Area, including U.S. Department of Agriculture easement programs; Federal Emergency Management Agency pre-disaster mitigation	See response to commment 5

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470	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	alternatives	Elevate Low-Lying Road Segments Road elevations are a well-recognized approach to ensuring access during flood events, and are eminently practicable. Targeted road elevations in the Yazoo Backwater Area would help ensure that Yazoo Backwater Area residents can access homes, businesses, and essential services during flood events. This work can be carried out through targeted use of Department of Transportation and other applicable programs and funding. Key road elevation needs have already been documented, and include the following low-lying road segments that flooded during the 2019 flood, according to the Mississippi Levee Board:	Comment noted. A section has been added to the EIS regarding transportation.
471	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	alternatives	Post-Disaster Recovery Assistance Effective use of post-disaster recovery funds is highly effective for reducing future flood risks and improving resilience, and highly practicable. Post disaster recovery funds are made available after every federal disaster declaration that covers the Yazoo Backwater Area. Notably, when such funds are used to assist in rebuilding substantially damaged structures, those structures must be elevated and floodproofed in accordance with the Federal Flood Risk Management 369 According to the 2007 FSEIS, the 5-year floodplain elevation is 94.6 feet NGVD and the 10-year floodplain elevation is 96.3 feet NGVD. 2007 FSEIS, Appendix 6 at 6-44. Conservation Organizations Comments on Yazoo Pumps June 2024 Draft EIS 94 Standard regardless of the type of disaster that caused the damage. For example, structures substantially destroyed by the March 2023 tornados that devastated Rolling Fork and other areas of Sharkey County must be elevated and floodproofed—and are being elevated and floodproofed—in accordance with the Federal Flood Risk Management Standard. Since elevations and floodproofing are already being implemented by FEMA and the Mississippi Emergency Management Agency in the Yazoo Backwater Area, both actions are clearly both feasible and practicable. Since 2016, the Yazoo Backwater Area has suffered from six federally declared Major Disasters resulting from floods, storms, and winds, and future disasters are likely to occur:	Comment noted, language has been added to the EIS for clarity.
472	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	alternatives	N. The DEIS Does Not Rigorously Explore and Objectively Evaluate Reasonable Alternatives and Does Not Select an Alternative that Protects and Restores the Yazoo Backwater Area To comply with NEPA, the DEIS must rigorously explore and objectively evaluate reasonable alternatives which are defined to mean "a reasonable range of alternatives that are technically and economically feasible and meet the purpose and need for the proposed action."370 Critically, the DEIS is not to be used to justify a decision that has already been made.371 The Water Resources Development Act of 2007 directs that all water resources projects are to reflect national priorities by "protecting and restoring the functions of natural systems."372 The Water Resources Development Acts also require the Corps to consider non-structural, natural, and nature-based measures when planning water resources projects.373 The Clean Water Act 404(b)(1) Guidelines prohibit the Corps from proceeding with a civil works project unless the Corps demonstrates that the project is the least environmentally damaging practicable alternative,374 which can only be done by examining a full range of reasonable alternatives. "An alternative is practicable if it is available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes."375 In developing and selecting alternatives, the DEIS also must comply with the full suite of federal laws and policies designed to protect the environment. These include the Endangered Species Act, the Clean Water Act, the Fish and Wildlife Coordination Act, the Migratory Bird Treaty Act, and the mitigation requirements applicable to Corps civil works projects.376 The alternative ultimately recommend by the EIS must also obtain a Clean Water Act water quality certification from the State of Mississippi. In short, the DEIS must evaluate a range of reasonable alternatives—including nonstructural, natural, and nature-based solutions that alone or in combination would protect and restore the natural functions of the rivers, streams, and wetlands in the Yazoo Backwater Area. The Corps must ultimately select an alternative that achieves these objectives while causing the least possible amount of harm to the environment. In addition to the many issues discussed in the other sections of these comments, in developing and evaluating alternative, the Corps must look beyond pre-conceived notions regarding the benefits that would be provided by the Yazoo Pumps Alternatives and instead carefully consider and account for solutions that could provide far more meaningful benefits to Yazoo Backwater Area communities.The DEIS does not look for solutions that would meaningfully address community problems, but instead continues to propose alternatives focused on attempting to artificially control that important flood regime to benefit industria scale agriculture in the Yazoo Backwater Area. The DEIS ignores the well-established value and effectiveness of non-structural, natural and nature-based measures that could provide meaningful solutions. The DEIS also ignores the reality that every iteration of the Yazoo Pumps that has been proposed, has ultimately been rejected.	See response to comment 5
473	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	alternatives	The DEIS Only Examines Alternatives that Primarily Benefit Industrial Scale Agriculture Since construction of the Yazoo Backwater Levee in 1978, the Yazoo Backwater Area has seen only one flood that reached the 25-year floodplain – during the unprecedented flooding in May 2019. Between 1978 and 2018, water levels in the Yazoo Backwater Area never reached the 20-year floodplain and exceeded the 10-year floodplain just 2 times (water levels also exceeded the 10-year floodplain for a single day in 2020).Notably, even during the prolonged 2019 flood, which was the largest in the Yazoo Backwater Area since construction of the Yazoo Backwater Levee, Yazoo Backwater Area farmers were also able to grow 316,000 acres of crops in 2019, which is more than 55% of the 10-year average acreage of crops grown in the Yazoo Backwater Area, according to USDA data.377 See additional discussion regarding Yazoo Backwater Area agriculture, below. During the 2019 flood, structural damages within the Yazoo Backwater Area counties were highly concentrated with 76% of all structural damage and 85% of all structural monetary damages occurring in Warren County, which includes the Eagle Lake community and extensive areas located outside of the boundaries of the Yazoo Backwater Area (see Figure below). In 2019, relatively few structures were affected by flooding in Issaquena and Sharkey counties, the two counties located entirely within the Yazoo Backwater Area, according to Mississippi Emergency Management data. Within Issaquena and Sharkey counties a total of 53 homes and 19 mobile homes were affected. Of those, 27 homes had onlyminor or very minor damage. Data for other counties include large areas that would not be affected by the Pumps. The targeted solutions proposed in the Resilience Alternative would provide reliable solutions to reduce flood damages for the Eagle Lake community. The Yazoo Pumps Alternatives, on the other hand, could make access to the Eagle Lake community even more difficult since the community's main access road—Highway 465—is located outside of the Yazoo Backwater Area (i.e., on the riverside of the Yazoo Backwater Levee) and would be on the receiving end of the up to 16 billion gallons of water a day discharged by the Yazoo Pumps Alternatives.Instead of carefully considering these facts it its assessment of project need, project benefits, and project alternatives, the Corps has continued its long history of developing Yazoo Pumps proposal with a singular goal of providing benefits to the region's industrial-scale agricultural producers. Indeed, the last time the Corps assessed benefits, more than 80% of project benefits came from agricultural intensification. Like every Yazoo Pumps plan before it, the Yazoo Pumps Alternatives are focused on facilitating agricultural production—and indeed, the entire operating plan is driven by the needs of agricultural producers by pumping water at levels expressly prohibited by the Clean Water Act veto throughout the entire 7-month crop season. The benefits from this pumping—and the overwhelming benefits of the Yazoo Pumps Alternatives—would go to extremely large farms owned by predominantly white agricultural producers. The average sized farm in the Yazoo Backwater Area is more than 2,900 acres, while the average farm in Mississippi is just 302 acres.378 In Sharkey County, 92% of agricultural producers are white, while 75% of the population is Black. In Issaquena County, 87% of agricultural producers are white, while 60% of the population is Black.379 Many of these agricultural producers already receive substantial income through federal farm subsidy payments.380 For example USDA data compiled through the Environmental Working Group Farm Subsidy Database shows that farms in the 16 zip codes that fall within the Yazoo Backwater Area received the following subsidies between 1995 and 2019 (see Figure below): • Yazoo Backwater Area recipients received a total of $1.05 billion in farm subsidy payments. • The top 5 recipients in the Yazoo Backwater Area received a total of $20.5 million, $17.4 million, $15.5 million, $14.2 million, and $10.7 million, respectively. • The top 5 recipients in each Yazoo Backwater Area zip code received a total of $430.7 million from 1995 to 2019—an average of $215,000 for each of 80 recipients every year for 25 years. • 272 recipients received more than $1 million each from 1995 to 2019—a minimum of $40,000 a year on average for each recipient every year for 25 years. By contrast, 25% of all households in the Yazoo Backwater Area counties of Issaquena and Sharkey earn less than $15,000 each year. In Issaquena County, 42% of the people live in poverty. In Sharkey County, 26% of the people live in poverty.	See response to comment 5

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474	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	Alternatives	P. The Yazoo Pumps Alternatives Do Not Conform to the Federal Flood Risk Management Standard The Yazoo Pumps Alternatives do not conform to the Federal Flood Risk Management Standard (FFRMS), which was enacted to ensure that federal agencies make sound flood risk and floodplain management decisions, including ensuring that federal flood mitigation projects will be resilient to floods that are larger than a 100-year flood event. This standard ensures a full consideration of risks, changes in climate, and vulnerability; encourages the use of natural features and nature-based approaches in the development of alternatives; and provides a higher vertical elevation and corresponding floodplain, where appropriate, to address current and future flood risks. Compliance with the planning requirements established by the FFRMS is mandatory for all federally funded projects like the Yazoo Pumps. The Federal Flood Risk Management Standard "requires executive departments and agencies to avoid, to the extent possible, the long- and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct or indirect support of floodplain development wherever there is a practicable alternative." The Federal Flood Risk Management Standard also sets forth guidelines to ensure a full consideration of risks, changes in climate, and vulnerability; requires stand-alone alternatives that use natural features and nature-based approaches; and provides a higher vertical elevation and corresponding floodplain, where appropriate, to address current and future flood risks. For example: If an agency has determined to, or proposes to, conduct, support, or allow an action to be located in a floodplain, the agency shall consider alternatives to avoid adverse effects and incompatible development in the floodplain. Where possible, an agency shall use natural systems, ecosystem processes, and nature-based approaches when developing alternatives for consideration. The Federal Flood Risk Management Standard also requires that flood risk reduction studies use one of the following three approaches for defining the relevant vertical elevations and corresponding floodplain: (1) Climate Informed Science Approach: Under this approach the Corps would use the elevation and flood hazard area411 that result from using the best-available, actionable hydrologic and hydraulic data and methods that integrate current and future changes in flooding based on climate science; (2) Freeboard Value Approach: Under this approach the Corps would use elevation and flood hazard area that results from adding an additional 2-feet to the base flood elevation for non-critical actions and by adding an additional 3-feet to the base flood elevation for critical actions; or (3) The 500-year floodplain approach: Under this approach the Corps would use the elevation and flood hazard area that is subject to flooding by the 0.2 percent annual chance flood Alternatives do not avoid the long- and short-term adverse impacts associated with the occupancy and modification of floodplains despite the existence of highly effective and practicable alternatives that would allow the Corps to do so. The Yazoo Pumps Alternatives also do not address current and future flood risk within the Yazoo Backwater Area and cannot make Yazoo Backwater Area communities resilient to floods that are larger than a 100-year flood event because the since the Yazoo Pumps Alternatives are only designed to provide relief to certain types of flood events, cannot provide relief during a 100-year flood event because doing so could result in overtopping the Yazoo Backwater Levee which came close to overtopping during the 2019 flood event and is specifically designed to overtop during a 100-year event to help protect Vicksburg. The DEIS also does not consider the planning requirements established by the FFRMS. For example, the DEIS has not demonstrated that: (1) the Yazoo Pumps Alternatives avoid highly significant adverse impacts to floodplain functions; (2) the Corps can restore and preserve the significant floodplain functions that would be lost to the Yazoo Pumps Alternatives; (3) the Corps adequately considered natural and nature-based solution alternatives; and (4) the Corps meaningfully considered and addressed the increased flood risks to downstream communities resulting from the discharge of 16 billion gallons of water a day into the Yazoo River when it is already at flood stage. The Corps also appears to have focused its entire plan on reducing impacts to non-food crops within the 5-year floodplain. Our organizations highlight that the FFRMS highlights that "certain agricultural uses and practices in the floodplain may adversely affect natural floodplain values" and notes that these constitute a type of incompatible floodplain development.413 Cotton, corn, and soy crops are notoriously resource intensive, polluting, and under standard farming operations would further erode natural floodplain values, which would be in conflict with the FFRMS that the Corps is required to follow. The Corps has not provided any evidence that agricultural producers in the Yazoo Backwater adhere to conservation practices that would be considered to not adversely affect natural floodplain values. Examples of such conservation practices would include flood-tolerant crops, low-impact husbandry, and regenerative agricultural practices. This is yet another reason why the Yazoo Pumps Alternatives encourage incompatible floodplain development. To ensure compliance with the FFRMS, the Conservation Organizations once again urge the Corps to implement the suite of measures outlined in the Resilience Alternative which is discussed in detail in Section M of these comments	See response to comment 5

Comment Number	Comment Date	Org.	Theme	Comment	Response
475	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	Economics	Q. The DEIS Does Not Assess Project Costs and Benefits For decades the cost of the Yazoo Pumps has never been justified by the prospective benefits. The economic costs of the Yazoo Pumps Alternatives have grown exponentially given the significantly larger size of these pumps and the power costs needed to operate the pumps. At the same time, the DEIS makes unfounded assertions that the pumps are essential to providing flood protection, and new employment opportunities in the farm service sector, for historically disadvantaged households and communities. This "environmental justice" argument has contributed to a DEIS that ignores traditional economic justifications for the pump while offering no evidence or explanation as to how the Yazoo Pumps Alternatives could conceivably be justified on environmental justice grounds. The DEIS should have prepared and evaluated alternatives, including the Resilience Alternative, that would result in the agricultural sector remaining productive and profitable with farmers continuing, as they do now, to benefit from USDA programs of price support and crop insurance, while offering landowners the opportunity to enroll in the Wetland Reserve Program. As part of this approach, the Corps could maintain and increase ecosystem services in the area by implementing promised but not yet completed mitigation and taking advantage of Federal programs and private market opportunities for wetlands afforestation. This approach offers a multi- agency environmental justice alternative to comprehensively and cost-effectively reduce areas subject to flooding, mitigate flood risk and upgrade housing stock at individual properties, creating certain and meaningful employment for the areas disadvantaged households. Such an alternative would be fiscally responsible by releasing some of the Corps' limited budget to address flood resiliency in other parts of the nation. To help advance this solution, and to fully assess the Yazoo Pumps Alternatives, the DEIS must—but does not—fundamentally reexamine the s economic costs and benefits of the Yazoo Pumps Alternatives. This reexamination is essential in light of the new data, changed conditions, cost increases, significantly larger pumps, and required power source, among other things. This fundamental reevaluation is also critical given the many deficiencies in the last such assessment, which was based on 2005 price levels.414 The DEIS must also ensure that the same criteria used to assess the geographic extent of wetland impacts (i.e., the new period of record and new flood frequency elevations referred to in the Notice of Intent and DEIS) is also used to assess the geographic extent of flood damage reduction benefits. The DEIS must also ensure that the benefit-cost analysis documents and fully accounts for the costs if all elements required to construct, operate, maintain, and mitigate the adverse impacts of the Yazoo Pumps Alternatives. Based on our estimates, constructing a 25,000 cfs pumping plant would cost well over $1.4 billion.415—which under the existing authorization would be fully funded by the federal taxpayers, with no local cost share. It will cost substantially more to construct all the other elements required to operate and maintain what would be the world's largest hydraulic pumping plant (including for example, constructing an energy source for these massive pumps). The mitigation that would be required for this plan would add significantly more to the project's enormous price tag. The Corps' cost estimate must also account for the economic realities facing the Corps today, including the Congressionally recognized fact that the "Corps has seen bids on important navigation and flood control projects come in at double or triple the previous cost estimates." The DEIS must also account for the inevitable—and potentially extremely significant—cost increases that will occur over time. For example, the Inland Waterways Journal reports that the most recent estimate of costs for the: (i) Kentucky Lock Replacement Project had "ballooned" by $332 million; (ii) Chickamauga Lock project had increased by $197.5 million or 26%; and (iii) Phase 2 of the Three Rivers project had increased by $76 million Significant cost increases are not a new phenomenon. For example, older cost estimate information shows that the: • American Rivers Common Features, CA increased by at least 1,863% (original estimated cost of $57 million increased to $1.2 billion, in part due to the need to make significant design changes to ensure public safety418). • Pump component of the Larose to Golden Meadow project, LA increased by at least 1,238% (original estimated cost of $800,000 increased to $10.7 million, due to design changes required to handle the actual site conditions419). • Olmstead Lock and Dam project, IL and KY increased by at least 277% (original estimated cost of $775 million increased to $2.9 billion, due in part to unaccounted for construction challenges420). • Turkey Creek Basin project, KS and MO increased by at least 152% (original estimated cost of $43 million increased to $108 million, including $10 million increase for major work required to access the construction site421). • Roanoke River Upper Basin project, VA increased by at least 113% (original estimated cost of $29 million increased to $61.7 million, due to required redesign to address the discovery of hazardous waste sites 422); • Monongahela Locks & Dam project, PA increased by at least 102% (original estimated cost of $556 million increased to $1.1 billion423). The Corps must then compare these costs to the project's purported benefits. In assessing benefits, the Corps must, among other things, pay careful attention to the elevations of acreage and structures being evaluated for benefits and the length of time it would take the pumps to draw water from those acres or structures under different flood scenarios. The Corps also must ensure that it does not count rate relief under the National Flood Insurance Program as a project benefit because the Yazoo Pumps Alternatives would not meaningfully reduce flood risks to communities. Importantly, the Corps must ensure that it does not calculate benefits on any of the 250,000-plus acres of conservation lands in the Yazoo Backwater Area—lands that are being managed precisely for their wetland values. The Corps also must ensure that it does not calculate benefits on any of the 19,463-plus acres of flooding and flowage easements owned by the Corps in the Yazoo Backwater Area or on mitigation lands owned by the Corps or others in the Yazoo Backwater Area.424 To the contrary, draining or degrading wetlands on any of these lands must be accounted for as project cost, which can be at least partially quantified through an assessment of ecosystem services lost on these lands due to the Yazoo Pumps Alternatives. Finally, the Corps must ensure that the benefits of any separable elements of the project, such as altering the operation of the Steele Bayou gates, are not used to economically justify the proposed 25,000 cfs pumping plant and its related infrastructure. Benefits resulting from mitigation activities also cannot be used to justify the proposed pumping plant and related infrastructure, as mitigation is designed to offset lost values.	See response to comments 5 and 8
476	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	Economics	1. Costs of Construction, Operations, Maintenance, and Mitigation The DEIS should develop and document a completely new estimate of project costs, including mitigation costs. Cost estimates developed for the 2007 study should not be relied on in any way given the many changes that have occurred since then. The 2007 study's cost estimates were based on 2005 price levels. Project costs should include the costs of constructing and operating all components of the Yazoo Pumps Alternatives both inside and outside of the Yazoo Backwater Area, including the pumping plant, inlet and outlet channels, stream channel modifications, power generating facilities, transmission lines, temporary and permanent road construction, staging areas, fuel costs, and the costs of any other types of activities that would be carried out during project construction, operation, and maintenance over the life of the project. Project costs should also include the quantified value of the ecosystem services that will be lost to the Yazoo Pumps Alternatives, as required by the March 2013 Principles and Requirements for Federal Investments in Water Resources and the December 2014 Interagency Guidelines that implement those Principles and Requirements (collectively, the PR&G). The PR&G apply to Corps projects, and the Corps is in the process of developing agency specific guidelines to ensure full implementation. The March 2013 Principles and Requirements state that evaluation methods "should apply an ecosystem services approach in order to appropriately capture all effects (economic, environmental and social) associated with a potential Federal water resources investment." The December 2014 Interagency Guidelines state that "Federal investment impacts on the environment or ecosystem may be understood in terms of changes in service flows. The process of identifying, evaluating, and comparing these changes provides a useful organizing framework to produce a complete accounting. Reduced service flows over time amount to costs, and increased services flows over time amount to benefits." The Guidelines also state: "Agencies must provide an explicit list of the services that flow from the existing study area ecosystems and infrastructure (including operational plans) with identification of those services that are likely to meaningfully change within the larger context of the watershed because of the Federal investment."	See response to comments 5 and 8

Comment Number	Comment Date	Org.	Theme	Comment	Response
477	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	Economics	2. Flood Damage Reduction Benefits—Agriculture The 2007 SEIS determined that more than 80% of the alleged benefits from the Yazoo Pumps would come from increased agricultural production—which makes it clear that agricultural drainage is the project's true primary purpose. Draining wetlands to promote increased agricultural production is an archaic concept from another era and is in direct conflict with current federal law and policy. The economic analysis in the Corps' 2007 FSEIS reported a BCR that "barely justified" the cost for what was, at the time that estimate was prepared, a $207 million project. As noted above, agricultural benefits accounted for more than 80% of the project's alleged benefits. However, as the Corps is aware, an extensive and independent economic review of the Corps' analysis exposed many extensive flaws in the Corps' 2007 economic assessment. That report, prepared by Leonard Shabman and Laura Zepp (the "Shabman Report") in cooperation with EPA,425 also determined that the Yazoo Pumps would do nothing more than "help landowners grow crops on land that is farmed only to earn farm subsidy payments"426 and that the significantly less costly derivation of the Yazoo Pumps considered in the 2007 EIS could not be economically justified.427 To justify construction of the Yazoo Pumps Alternatives as the NED plan (which continues to be required because the agency specific procedures for implementing the PR&G have not been finalized), the Corps would need to demonstrate that the present value of the NED agricultural benefits, which dominated the Corps' 2007 NED justification for the pumps, have increased enough to offset: (i) the net present value of the significant construction costs of the proposed 25,000 cfs pumps; and (ii) the significant reduction in agricultural acres available to benefit from operation of the Yazoo Pumps Alternatives due to significant acres of croplands having been transitioned to conservation lands and forest production since the 2007 EIS. However, nothing has changed in the Yazoo Backwater Area's agricultural economy, in the broader agricultural economy, in the watershed, or in the basic logic of the pump formulation that could justify a finding that the net present value of agricultural benefits could have grown enough since the 2007 FSEIS analysis to exceed the net present value of the $1.4+ billion costs to construct the 25,000 cfs pumps. For example: (1) The costs of production in Mississippi relative to inflation have increased since the Corps prepared the economic analysis it used in the 2007 report, reducing net returns per acre in each year.428 (2) Prices for crops grown in the Yazoo Backwater Area, relative to general inflation, have not increased, reducing net returns per acre. For example: (3) Crop yields have not grown at the significant rate that would be necessary to offset the effects on NED of fewer acres, lower prices and higher costs. To offset these effects on NED, the difference in crop yields and changes in crop patterns on lands made "flood-free" by the Yazoo Pumps Alternatives would need to grow much more significantly than the already significant increases in growth projected in the 2007 FSEIS economic analysis. If the trends in prices and costs between 2002 and 2022 are used to extrapolate future prices and costs, those trends would not warrant a claim of significant increases in net returns on the flood prone land made less flood prone by the pumps. 430 Given the many flaws in the analysis used by the Corps in the 2007 FSEIS, it is essential that the DEIS conduct a fundamentally new and comprehensive assessment of agricultural benefits. This new economic analysis also must be fully evaluated by, and be consistent with, the recommendations provided by both internal and independent external peer reviews. Notably, the Corps may not rely on plan elements unrelated to the pumping plant to economically justify agricultural benefits because those elements are unquestionably separable elements that are unrelated to agricultural production. This would include such things as changes in the operation of the Steele Bayou flood control gates (which can be done immediately and is completely unrelated to the proposed pumping plant), and nonstructural or nature-based elements, and of course anything related to mitigation which is intended to offset adverse impacts and thus, does not create a benefit The new economic analysis must carefully assess and account for at least the following: (1) A full assessment of farm ownership in the areas of the Yazoo Backwater Area that would be able to intensify agricultural production due to operation of the Yazoo Pumps, to ensure that the concentration of benefits warrants the large investment of federal taxpayer dollars that would be required to construct and operate the Pumps. The 2007 FSEIS noted that there were only 192 farms in the project area with an average size of 2,913 acres.431 The 2007 FSEIS did not provide farm ownership information, so it is was not possible to discern whether some landowners or corporations own multiple farms in the project area. As discussed in Section N.1 of these comments, the limited number of farms, and the industrial size of those farms reinforce the fact that the Yazoo Pumps Alternatives prioritize benefits to industrial scale agriculture at the expense of vulnerable Yazoo Backwater Area communities and the environment. (2) A full assessment of farm subsidy payments in the Yazoo Backwater Area to assess whether additional subsidies to intensify agricultural production are in fact necessary or an appropriate investment of federal taxpayer dollars. As the Corps is aware, an extensive and independent economic review determined that the Yazoo Pumps would do nothing more than "help landowners grow crops on land that is farmed only to earn farm subsidy payments," based on the economic data used by the Corps in the 2007 SEIS.432 That review also determined that the Yazoo Pumps could not be economically justified even at what was then a $207 million projected construction cost.433 (3) A full and accurate accounting of land use and related elevations in the Yazoo Backwater Area.Agricultural benefits must be carefully assessed only on agricultural lands that would see reduced levels of inundation during the growing season sufficient to justify more intensive agricultural practices. No agricultural or other flood damage reduction benefits should be calculated for conservation and easement lands in the Yazoo Backwater Area. No agricultural or other flood damage reduction benefits should be calculated for lands used for mitigation for the Yazoo Pumps or other projects. The value of ecosystem services lost on agricultural (and all other) lands must be accounted for as a project cost. (4) A full comprehensive assessment of farm elevations in the Yazoo Backwater Area, to ensure that only those farms in areas that could see reduced flood inundation are accounted for in the benefits analysis, and to ensure that no benefits are counted for farms lying below the 91-foot NGVD elevation since the 2008 Clean Water Act veto prohibits pumping below this elevation. The Corps is also prohibited from pumping below the 90-foot NGVD elevation under the current authorization, which designates lands "located below 90 feet, NGVD, in elevation to serve as a sump area for surface water storage."434 The 2007 FSEIS did not provide any information on the elevation of farms. (5) A comprehensive assessment of whether the Yazoo Pumps would in fact provide any statistically significant benefit to agricultural production, or would instead harm agricultural production in the Yazoo Backwater Area. A scientific study conducted in the Yazoo River Basin strongly suggests that the Yazoo Pumps would harm—not help—agricultural production in the Yazoo Backwater Area.435 This study looked at the riverine hydrological and regional climatic regime relationships to agriculture (cotton, soybeans) and the principal riverine fish stocks in the upper Yazoo River basin. The study looked at 31 years of data (from 1964 to 1994) to compare flooding in the study area with soybean and cotton production. It found that "no factor associated with flood events adversely influence production of cotton and soybeans. However, with regard to soybeans, the amount of area flooded two years prior to a crop was positively related to soybean yield. From a long-term perspective therefore, the data suggest that flooding may benefit agricultural enterprises associated with soybean production."436 The study also found that cotton yield was positively correlated with maximum area flooded during the same year, noting that this was likely due to increased soil moisture which benefits cotton production. This was true even though floods resulted in fewer acres of cotton being planted during flood years.437 The study did note, however, that a different pattern appeared to emerge over shorter time periods "which may explain the public perception that flooding adversely impacts agriculture in the area. During the 5 year period from 1990-1994, high precipitation was negatively related to area planted in cotton and the percent of the area planted in soybeans that was actually harvested. However, flooding during this period did not significantly affect overall yield of cotton and soybeans."438 And again, there was a positive correlation between cotton yields and the maximum area flooded during the same year. That same study also shows that flooding benefits fisheries in the area, finding a positive relationship between flooding and positive fish stock characteristics, which the study defines as more and bigger fish. The study also noted that much of the productive potential for fisheries in floodplain river ecosystems is determined by the dynamics of overbank flooding and riparian vegetation.439 The ability to plant crops even during years with large flood events. Even during the prolonged 2019 flood event, 316,000 acres of crops were grown in the Yazoo Backwater Area (more than 55% of the 10-year average acreage of crops grown in the Yazoo Backwater Area), according to USDA data.440 This data would appear to contradict the statement in the NOI that "Farmers lost their entire 2019 crop season in the affected area."441 In addition, the Conservation Organizations understand that farmers were eligible to receive disaster relief or other forms of compensation to minimize economic losses due to the inability to plant crops on the Yazoo Backwater Area lands that could not be planted as a result of the 2019 flood event. In 2008, then Mississippi Governor Haley Barbour stated on Mississippi Public Radio that even during the 100-year flood of 1973, farmers had good soybean crops. Indeed, we understand that many farmers prefer to plant after floods because it is cheaper to do so. Post-flood planting reduces the amount of chemicals that must be applied to the land to clear the fields, and reduces the amount of fertilizer needed due to the nutrients provided by the flooding. (6) A full assessment of actual crop losses in the areas that could see reduced inundation under the Yazoo Pumps Alternatives, and a full assessment of the amount of any such losses that are uninsured and/or otherwise unsubsidized. Only uninsured losses (less any subsidies) that could be reduced by operation of the Yazoo Pumps should be accounted for in the assessment of project benefits.	See response to comments 5 and 8

Comment Number	Comment Date	Org.	Theme	Comment	Response
478	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	Economics	3. Flood Damage Reduction Benefits—Homes, Businesses, Structures In assessing flood damage reduction benefits to homes, businesses, and other structures, the Corps should utilize an up-to-date inventory of all structures and roads in the Yazoo Backwater Area. This inventory must utilize precise elevation data collected through FEMA's approved elevation survey methodology to determine the elevation of the lowest inhabited floor (as opposed to just the elevation of adjacent land). Flood damage reduction benefits for structures and other infrastructure may only be calculated for areas and elevations that would see reduced levels of flood inundation. The Corps should also ground truth its quantification of flood damage reduction benefits, including by comparing the predicted benefits with the limited, and highly concentrated, structural damage incurred during the 2019 flood. Before assessing potential flood damage reduction benefits for the Eagle Lake Community, the Corps should conduct a detailed after-action assessment of the cause of the 2019 Eagle Lake area flooding. Factors that likely influenced the 2019 flooding of homes near Eagle Lake include the Lake's water control management regime and actions associated with maintaining the stability of the portion of the Mississippi River mainline levee that abuts Eagle Lake. Deficiencies in the Brunswick Circle Levee, a private levee first built in the 1880s, also likely played a role in the 2019 flooding near Eagle Lake. Brunswick Circle encompasses 4,000 acres of land in the Eagle Lake area, and is home to 230 residents and one church, as reported by the Vicksburg Post. In 2022, the Mississippi Legislature awarded $75,000 to Warren County to pass through to the landowner to address the Brunswick Circle Levee deficiencies.442 If these factors played a role in the flooding surrounding Eagle Lake, it is likely that the area would have flooded in 2019 even if the Yazoo Pumps were in operation. The multiple risk factors facing Eagle Lake must be accounted for when calculating any flood damage reduction benefits for the Yazoo Pumps. The discussion of benefits must also account for the fact that all structures in the Yazoo Backwater Area that were substantially destroyed by the devasting tornado that swept through Rolling Fork and Sharkey County on March 24 (at least 300 homes and businesses), that are being rebuilt with the assistance of funding provided by the federal government, must be rebuilt above the 100-year floodplain elevation—far above the 5-year floodplain elevation that is the focus of the Yazoo Pumps Alternatives and at an elevation that is above the flood-level elevation when the pumps can be used. See discussions above regarding the inability to use the Yazoo Pumps during a 100-year flood event. The Corps should also take steps to ensure that it does not overstate potential benefits as it clearly did in the 2007 study. For example, the 2007 FSEIS claims that the average household in the project area has two automobiles valued at $15,000 per car. The Corps says that despite the low velocity flooding typical in the study area that about 1/3 of these cars will get flood damages estimated at $298,000 per year. These estimates make no sense given the economics in the project area. At the time these values were assessed, the average per capita income in Sharkey and Issaquena counties was $11,187, and one third of the population lived below the poverty level. Median household income was approximately $20,000 to $22,000 depending on the county. Based on these economic realities, it is highly unlikely that each home would have two cars valued at $15,000 sitting in the driveway, or that if this were the case, it is even more unlikely that the owners would not simply drive their cars to higher ground during the typical slow-moving flood event.	See response to comments 5 and 8
479	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	Economics	4. Benefits of Nonstructural, Natural, and Nature-Based Measures The Corps should account for the value of ecosystem services provided by nonstructural, natural, and nature-based measures (and to account for the losses in ecosystem services resulting from the Yazoo Pumps Alternatives to ensure proper assessment of these approaches. In carrying out these assessments, the Corps should use the many existing well-established ecosystem services valuation tools and studies, including the Duke University, Nicholas Institute report on Valuing Ecosystem Services from Wetland Restoration in the Mississippi Alluvial Valley, and the Earth Economics report Gaining Ground, Wetlands, Hurricanes, and the Economy: The Value of Restoring the Mississippi River Delta. In addition to fully accounting for ecosystem service values, the Corps should also account for the following benefits when evaluating nonstructural, natural, and nature-based measures: Avoiding costs of flood-fighting and dislocation borne by federal and state agencies, local municipalities, and the public. • Avoiding costs to U.S. Department of Agriculture Commodity programs, Federal Crop Insurance, and Noninsured Crop Disaster Assistance programs. A recent study documents these avoidance benefits (present value of avoided costs less Wetland Reserve Easement Program and restoration costs) in Mississippi at $870 per acre. Wetland Reserve Easement Program Economic Assessment: Estimated Commodity Program and Crop Insurance Premium Subsidy Cost Avoidance Benefits, prepared for the Nature Conservancy (June 2, 2018) (authored by retired U.S. Department of Agriculture economist Dr. Doug Lawrence). • National Flood Insurance Program Rate Reductions: Protecting floodplains has the largest impact on lowering National Flood Insurance Program (NFIP) rates for communities participating in the voluntary Community Rating System Program (CRS). Participation in the CRS can reduce NFIP rates from 15% to 45%. The CRS credits over 90 elements of comprehensive floodplain and watershed management, including providing significant credits for protecting the natural functions of riverine floodplains by preserving natural floodplain open space, acquiring flood-prone land and returning it to its natural state, and protecting and restoring natural floodplain functions and habitat	See response to comments 5 and 8
480	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	EJ	More than 75 Black community members and leaders are on record as opposing the Yazoo Pumps Alternatives13 and have repeatedly urged the Corps to "abandon any version of the Yazoo Pumps."14 These residents "have told the Corps over and over again" that they "want effective flood relief through nonstructural and nature-based solutions that honors and respects our underserved communities—not the false promise of the Yazoo Pumps."15 These community members also strongly oppose the Yazoo Pumps Alternatives' "mandatory acquisition"—through eminent domain and condemnation—of all structures below the 90-foot elevation (101 structures), including 52 homes in economically disadvantaged communities in the Yazoo Backwater Area16: On top of pushing another sham version of the Yazoo Pumps onto our communities, you now propose to take our homes and property through eminent domain and condemnation under the shameful perversion of environmental justice. This is not flood relief, this is a violation of the generational struggles our Black communities have endured in rising up against abuse,poverty, and injustice. The legacy of our communities and our families will not be sacrificed to feed the desire of affluent farm owners.17 Ty Pinkins, the Founder and President of the Pyramid Project, a non-profit in the Yazoo Backwater Area, has advised both the Corps and the Environmental Protection Agency that the Yazoo Pumps Alternatives are "unacceptable and offensive" and "a slap in the face to Black community members of the Yazoo Backwater Area."18 He also wrote that the decision to move forward with this proposal "casts aside the honest requests many other minority community members and I have made in asking you to disavow the Yazoo Pumps and put your energies into providing effective 21st-century flood relief programs and environmental justice resources, especially through nonstructural and nature-based approaches."19 The Corps has been aware of this community opposition since at least August 2023, when 50 community members submitted scoping comments urging the Corps "to abandon this and any version of the Yazoo Pumps and to instead work with the Environmental Protection Agency, U.S. Department of Agriculture, and others to quickly implement nature-based and non-structural solutions that can help us recover and thrive."20 These community members also told the Corps that: For decades, the Yazoo Pumps have been held out as the promised solution to flooding in our counties and the rest of Mississippi's Yazoo Backwater Area, but we are not fooled. The Yazoo Pumps will not keep us safe from flooding—the Pumps will simply help enrich large farm owners so they can plant more crops on low-lying lands while our needs and requests continue to be ignored. The hundreds of millions, and likely billions, of our tax dollars needed to build the pumps would be far better spent on providing meaningful flood relief and economic opportunities to help redress the environmental and other injustices that plague our communities of color. Also, it is outrageous that these same pumps would dump billions of gallons of water downstream, making flooding problems even worse for our mostly Black neighbors in North Vicksburg. Our overlooked communities need effective flood relief now—not the false promise of the Pumps.21 In his scoping comments, Mr. Pinkins expressed shock that the Biden Administration would pursue the Yazoo Pumps:[Y]our agencies' recent decision to push yet another variation of the Yazoo Pumps is a slap in the face to the communities of color in the Yazoo Backwater. It really is quite shocking that the Biden Administration would propose this project, since its true purpose is to help already rich farm owners get even richer by planting more crops on their large low-lying farms while theneeds and requests of Black community members continue to be ignored. Inexcusably, these same pumps will dump billions of gallons of floodwater downstream, making flooding problems even worse for our mostly Black neighbors. Simply put, the Yazoo Pumps are a blatant environmental injustice. The hundreds of millions, and likely more than a billion, of our tax dollars needed to build the pumps would be far better spent on providing meaningful flood relief and economic opportunities to help redress the environmental and other injustices that plague the Yazoo Backwater Area's Black community members	Current project enhancements include offering only a voluntary buyout plan or dry-floodproofing if owners decide not to particpate in the buyout for those in the below 93 foot flood extent. Mandatory buyouts are OFF the table. Estimates are that the proposed project pumps provides flood risk redcution benefits to almost 300 residential structures in the EJ community. These residential structures in the 98.2-93 foot level extent could see first floor flooding decrease to no longer flooding with the pumps in place. To assist homeowners who are eligible for the voluntary buyout with the relocation costs, other agencies, or through a federal mandate, are being identified for sources of funding to bridge the financial gap. Buyout of residential structures includes the provision of fair market value for residential structures and the possibity of a differential payment of relpalcement cost value if the cost of the relocation home is considerbly higher.

Comment Number	Comment Date	Org.	Theme	Comment	Response
481	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	EJ	In their scoping comments, the Education, Economics, Environmental, Climate and Health Organization (EEECHO) advised the Corps that the Yazoo Pumps are an "environmental injustice" that would simply "continue the South Delta's long history of prioritizing profits for wealthy farm owners at the expense of Black community members" and would send "more money to Delta farmers while leaving backwater communities unprotected and making flooding problems even worse for predominantly Black neighbors who live downstream."EEECHO also advised the Corps that the "Yazoo Pumps' false promise of floodprotection will not redress the long history of environmental injustices and complex hardships faced by South Delta communities."	See response to comment 480
482	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	EJ	O. The DEIS Does Not Meaningfully Address Downstream Flood Risks The DEIS does not meaningfully address the risk that the Yazoo Pumps will increase flooding for vulnerable downstream communities. When operating at full capacity, a 25,000 cfs pump would push more than 16 billion gallons of water a day into the Yazoo River when the river is already at flood stage (when the Steele Bayou flood control gates are closed due to backwater flooding from the Yazoo River), increasing flood risks for highly vulnerable communities downstream, including the Ford Subdivision in North Vicksburg where 93% of residents are Black and 61% of households are low-income. The Ford Subdivision already floods on a regular basis. The Corps has not properly examined the significant risks of its 25,000 cfs pump on these vulnerable communities downstream. Instead, the Corps has relied on a single 3 sentence email, and the same extremely flawed downstream flood model it used in 2019 to claim that the Yazoo Pumps Alternatives would not increase flood risks downstream. The Corps asked the Warren County Emergency Management Agency whether all the homes that had flooded in 2011 Mississippi River flood were raised or bought out so that "if a 2011 event were to occur today then none of the homes would be flooded or flooded with people inhabiting those homes." In response the Director of the Warren County Emergency Management emailed the following reply (this response is quoted in its entirety): Yes, that is correct for the most part. We lost most of those files that were done electronically, but we do have some paper files on them, but most were either raised or demolished, same with the backwater losses too. There were some buyouts and those were demolished.404 This email does nothing to confirm that operation of the massive 25,000 cfs Yazoo Alternative pumping plants will not increase flood risks downstream. The 2019 model that the Corps continues to rely on to assess downstream impacts is so flawed that it "cannot be trusted to get a correct answer" as documented in a comprehensive review of that model conducted in 2020 by William Fleenor, Ph.D., an expert with more than 25 years of experience with hydrologic modeling.405 Dr. Fleenor's report and CV are provided at Attachment J. Dr. Fleenor's review concludes that the model used by the Corps is fundamentally unreliable and "cannot be trusted to get a correct answer" regarding the impact of the Yazoo Pumps on flood levels in the Yazoo River: The U.S. Army Corps of Engineers used a one-dimensional hydrodynamic HEC-RAS model to assess the downstream impacts of the Yazoo Backwater Pumps on water elevations (stage) in the Yazoo River during the peak 2019 event. Review of that Model demonstrates that it is not capable of accurately examining stage changes in the Yazoo River because it provides a poor and very inaccurate representation of the Yazoo River, does not properly match measured stages and flows, uses obviously inappropriate boundary conditions, and is not sufficiently calibrated. More specifically, the Model represents the lower reach of the Yazoo River (the area most likely to be affected by the Yazoo Pumps) as being 17.5 miles, or 37.5%, longer than it actually measures, and this added length alone disqualifies the Model from being reliable. The Model also includes many cross-sections for the Yazoo River that are wider than justified, which results in the Model producing a Yazoo River that can convey more water than reality. The Model demonstrates extraordinarily little tendency to match the amount of timing of the measured flow in the lower reach of the Yazoo River, with the modeled flows at the USGS Redwood gage location (the closest upstream gage to the proposed location of the Yazoo Pumps) often peaking while flows measured by the Redwood gage are in a trough, and the six-month simulation of the Model producing modeled flow at the Redwood gage with 76.2 billion cubic feet less than measured by that gage. Due to the use of inappropriate flow boundary conditions, the Model predicts stage and flow levels that do not match the levels measured by gages in 2019. The base model performance of stage and flow at Yazoo River gages indicates that the Model was not calibrated and thus cannot be trusted to get a correct answer under any type of changes, such as the additional flows generated by the pumps. The Model must be more accurately defined, and the boundary conditions better established before the Model can be properly calibrated, and then used to assess the impacts of the Yazoo Backwater Pumps. Use of a two-dimensional model would provide a much better assessment of stage elevations in the primary area of interest due to many of the flows being across the main Yazoo River channel and the crossflow area from the Mississippi River.406 In short, as exposed by the Fleenor review, the Corps' model inaccurately assumes that the river is wider and longer and has less water in it than reality—and thus, that the Yazoo River has more capacity to handle the pumps discharge without overflowing its banks than it actually has. As of May 4, 2023, the Corps had not corrected the many flaws documented in Dr. Fleenor's review407 and the Conservation Organizations have seen no indication that the Corps has corrected this model since that time. It is critical that the Corps correct the many flaws in its downstream flood model and then use that corrected model to assess the impacts of the Yazoo Pumps Alternatives (and multiple variations of operating a 25,000 cfs pumps): (1) on water level elevations in the Yazoo River; (2) on flood and other risks to downstream communities, including communities in North Vicksburg; (3) on the main access road to Eagle Lake, Highway 465—which is located outside of the YBWA (i.e., on the riverside of the Yazoo Backwater Levee) and would be on the receiving end of the 16 billion gallons of water a day discharged by the Yazoo Pumps; and (4) on water levels in the Mississippi River	Comment noted. The modeling effort has been updated in 2023-2024 and extensive work has been put into impacts to the downstream areas both at the Vicksburg gage and homes on the north side of Vicksburg.
483	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	General Opposition	The National Wildlife Federation, National Audubon Society, Sierra Club, Audubon Delta, Sierra Club Mississippi, and Healthy Gulf (the "Conservation Organizations") appreciate the opportunity to provide comments on the Corps of Engineers' (Corps) Draft Environmental Impact Statement for the Yazoo Backwater Area Water Management Project dated June 2024 (the "DEIS"). Our organizations steadfastly oppose the proposed 25,000 cubic-foot-per-second (cfs) pumping plant and any other variation of the destructive, dangerous, and costly Yazoo Backwater Pumps and once again call on the Corps to permanently abandon consideration of this and any variation of the Yazoo Pumps. The Corps should instead support and advance the prompt deployment of the non-structural, natural, and nature-based flood risk reduction solutions outlined in the Conservation Organizations' Resilience Alternative—solutions that have also been requested by many local community leaders, the U.S. Fish and Wildlife Service, the U.S. Environmental Protection Agency (EPA), and many others.The Conservation Organizations steadfastly oppose Alternatives 2 and 3 (Yazoo Pumps Alternatives) and call on the Corps to take these alternatives and all derivations of the destructive, ineffective, and costly Yazoo Pumps off the table once and for all. The Corps should instead advance the deployment of demonstrably effective natural, nature-based and non-structural solutions for the Yazoo Backwater Area, which are included in the Conservation Organizations' Resilience Alternative.1	See response to comment 5
484	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	General Opposition	Every previous iteration of the Yazoo Pumps has been rejected. In 1958, the Corps' Chief of Engineers recommended a plan without the Yazoo Pumps. In 1959, the Chief of Engineers concluded that Yazoo Pumps were not needed because the authorized level of flood protection had already been provided by other projects. In 1986, the non-federal sponsor chose not to proceed with the project in light of the newly established non-federal cost share requirement. In 1991, the Office of Management and Budget rejected another Yazoo Pumps study, directing a fundamental reevaluation of the project that that fully considers "predominately nonstructural and nontraditional measures." In 2008, the George W. Bush Administration EPA stopped the project by issuing just the 12th Clean Water Act 404(c) veto in history, with strong support from the Department of the Interior. In late 2021, the Biden Administration EPA stopped yet another attempt to build the Yazoo Pumps by reasserting the 2008 Clean Water Act veto. The Conservation Organizations call on the Corps to follow suit and abandon the destructive and dangerous Yazoo Pumps Alternatives. The Yazoo Pumps Alternatives, like all derivations of the Yazoo Pumps before it, would cause unacceptable harm to hemispherically significant wetlands to increase profits for highly subsidized agricultural producers. The Yazoo Pumps Alternatives would increase flood risks for highly vulnerable communities downstream without providing meaningful protection to vulnerable communities in the Yazoo Backwater Area. Instead of continuing to push the unacceptable and vetoed Yazoo Pumps, the Corps and other federal agencies should support deployment of highly effective non-structural, natural, and nature-based flood risk reduction solutions as requested by many local community leaders and the conservation community.	EPA implements CWA section 404(c) and issued the 2008 section 404(c) Final Determination concerning the Yazoo Backwater Area Pumps Project. USACE therefore cannot speak to the applicability of EPA's Final Determination. See response to comment 5.

Comment Number	Comment Date	Org.	Theme	Comment	Response
485	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	H+H	Each of the Yazoo Pumps Alternatives are prohibited by mandatory Clean Water Act 404(b)(1) Guidelines, which strictly prohibit a "discharge into the aquatic ecosystem unless it can be demonstrated that such a discharge will not have an unacceptable adverse impact either individually or in combination with known and/ or probable impacts of other activities affecting the ecosystem of concern."9 The degradation or destruction of wetlands "is considered to be among the most severe environmental impacts covered by" the 404[b](1) Guidelines.10 The Yazoo Pumps Alternatives are prohibited by the 404(b)(1) Guidelines because, among other things, these alternatives unquestionably "will cause or contribute to significant degradation of the waters of the United States,"11 and because there are practicable alternatives that "would have less adverse impact on the aquatic ecosystem."12	EPA implements CWA section 404(c) and issued the 2008 section 404(c) Final Determination concerning the Yazoo Backwater Area Pumps Project. USACE therefore cannot speak to the applicability of EPA's Final Determination. See response to comment 5.
486	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	H+H	If the operating plan does change, project-induced impacts could increase well above the already unacceptable levels currently identified in the DEIS. This is a very real risk, including because the Corps has not provided an actual operating plan in the DEIS, leaving the public with no ability to assess the actual impacts of that plan—which like most Corps operating plans will likely include options for multiple deviations from the plan's typical parameters. As importantly, operating plans can—and typically do—change over time. Indeed, the Corps' regulations require the Corps to "keep approved water control plans up to date" including by subjecting those plans "to continuing and progressive study by personnel in field offices of the Corps of Engineers."49to expedite this update in the Water Resources Development Act of 2018, 55 Congressional direction is neither required nor expected. The New Madrid Floodway provides another example, where the operating plan for activating the New Madrid Floodway to reduce flood stages on the Mississippi River has changed significantly over time, without Congressional direction. When initially authorized in 1928, the floodway was to be activated when water levels were predicted to reach 55 feet at Cairo, Illinois. This activation level was increased to 60 feet in the Flood Control Act of 1965. The Corps raised the activation level to 61 feet in 1968 by modifying the operating plan. These changes helped protect agricultural production in the floodway at the expense of public safety and the environment. In 2011, the Corps chose not to follow the operating plan but instead waited until water levels reached 61.72 feet before activating the floodway. This was far above both the authorized activation level and the 1986 activation level. This delay occurred even though the Corps had extensive advance notice of the flood threat.56 The delay was due in large part to a lawsuit filed by the state of Missouri to stop the floodway's use. "Missouri officials had fought hard to stop the plan, filing court actions all the way to the U.S. Supreme Court."57 While Missouri eventually lost its legal challenge, critical time was lost as the legal battle played out in court. The delay in activating the floodway resulted in extensive flooding. More than 200 structures flooded in Olive Branch, Illinois. Almost 240 homes were flooded in the City of Metropolis, Illinois, and dozens of businesses were either closed or greatly affected by high water. Lost revenue, flood fighting and clean-up costs from the 2011 flood cost Metropolis almost $1.4 million.58 The entire City of Cairo, Illinois, was put under a mandatory evacuation order. Residents were forced to leave their homes and find alternative places to stay. Cairo could have been destroyed by any further delay. Once the floodway was used, water levels at Cairo dropped 1 foot in just 6 hours, and 2.7 feet in just 48 hours. The Corps' Engineering Regulations also direct that water control plans should be reviewed "no less than every 10 years and shall be revised as needed in accordance with this regulation."50 Those regulations also state that the development of water control plans "continues as new information becomes available during project implementation" and that water control plans "will be revised as necessary to conform with changing requirements resulting from developments in the project area and downstream, improvements in technology, improved understanding of ecological response and ecological sustainability, new legislation, reallocation of storage, new regional priorities, changing environmental conditions and other relevant factors."51 The Corps' Engineering Regulations also contemplate recurring deviations from operating plans. For example, instead of prohibiting deviations, the Corps' Engineering Regulations state that deviations "that impact the fulfillment of authorized purposes, that occur in three or more consecutive years, or that occur more than three times within a five-year period must be fully coordinated with CECW-CE."52 Indeed, the regulations allow "[s]ignificant, recurrent or prolonged deviations from operations prescribed by an approved water control plan" unless the division commander decides that such deviations "indicate a need for a formal change to operations prescribed by an approved water control plan."53 Importantly and disturbingly, there is no requirement to notify the resource agencies or the public of any such deviations. It will also be difficult—and possibly impossible—for resource agencies or the public to know whether the Corps is in fact following the operating plan or deviating from it during a particular flood event. As a result, the operating plan for the selected alternative cannot provide a reliable backstop for managing environmental harm or selecting the least environmentally damaging practicable alternative, as required by the Clean Water Act. To the contrary, a Yazoo Pumps operating plan (or modified operating plan) may well be fleeting, unreliable, and unenforceable. There are numerous examples of the Corps changing operating plans. For example, the Corps recently finalized an update to the water control plan for Lake Okeechobee.54 While Congress directed the Corpsto expedite this update in the Water Resources Development Act of 2018, 55 Congressional direction is neither required nor expected. The New Madrid Floodway provides another example, where the operating plan for activating the New Madrid Floodway to reduce flood stages on the Mississippi River has changed significantly over time, without Congressional direction. When initially authorized in 1928, the floodway was to be activated when water levels were predicted to reach 55 feet at Cairo, Illinois. This activation level was increased to 60 feet in the Flood Control Act of 1965. The Corps raised the activation level to 61 feet in 1968 by modifying the operating plan. These changes helped protect agricultural production in the floodway at the expense of public safety and the environment. In 2011, the Corps chose not to follow the operating plan but instead waited until water levels reached 61.72 feet before activating the floodway. This was far above both the authorized activation level and the 1986 activation level. This delay occurred even though the Corps had extensive advance notice of the flood threat.56 The delay was due in large part to a lawsuit filed by the state of Missouri to stop the floodway's use. "Missouri officials had fought hard to stop the plan, filing court actions all the way to the U.S. Supreme Court."57 While Missouri eventually lost its legal challenge, critical time was lost as the legal battle played out in court. The delay in activating the floodway resulted in extensive flooding. More than 200 structures flooded in Olive Branch, Illinois. Almost 240 homes were flooded in the City of Metropolis, Illinois, and dozens of businesses were either closed or greatly affected by high water. Lost revenue, flood fighting and clean-up costs from the 2011 flood cost Metropolis almost $1.4 million.58 The entire City of Cairo, Illinois, was put under a mandatory evacuation order. Residents were forced to leave their homes and find alternative places to stay. Cairo could have been destroyed by any further delay. Once the floodway was used, water levels at Cairo dropped 1 foot in just 6 hours, and 2.7 feet in just 48 hours.	Comment noted. Methodologies for addressing potential changes to project operation will be outlined in the interagency MOAs.

Comment Number	Comment Date	Org.	Theme	Comment	Response
487	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	Mitigation	The DEIS Drastically Understates the Amount of Mitigation Needed and Violates Multiple Mitigation Mandates The DEIS drastically understates the amount of mitigation that would be required to attempt to offset the unacceptable "damages to ecological resources, including terrestrial and aquatic resources, and fish and wildlife losses"331 from the Yazoo Pumps Alternatives. The DEIS does not propose enough mitigation to offset the adverse impacts it has identified as required by 33 U.S.C. § 2283(d). The compensatory mitigation plan provided with the DEIS does not satisfy the requirements established by 33 U.S.C. § 2283(d). And the DEIS does not analyze mitigation measures with "sufficient detail to ensure that environmental consequences have been fairly evaluated"332 as required by NEPA. The Conservation Organizations do not believe it is possible to mitigate the adverse impacts to the full suite of ecological resources and fish and wildlife that would be harmed by the Yazoo Pumps Alternatives or any other derivation of the Yazoo Pumps. This assessment is borne out by decades of experience, and repeated confirmations by EPA—including in the 2008 Clean Water Act veto, and the scientific community. The 2008 Clean Water Act veto explicitly determined that the Yazoo Pumps' significant adverse impacts could not be adequately mitigated by the Corps' proposal which was inconsistent with the requirements of the Clean Water Act.333 The Corps' continued inability to meaningfully mitigate the impacts of the Yazoo Pumps Alternatives is exemplified by its shockingly low mitigation proposal. The Corps contends (in Mitigation Alternative 4) that just "7,650 acres of wetlands are estimated to be needed for compensatory mitigation for the project" because "[w]etlands have the highest mitigation need and meeting the acres needed for wetland compensation will mitigation for the other resources (Table 3)."334 The Conservation Organizations are at a loss to understand how this extremely minimal amount of mitigation on lands whose hydrology would also be adversely affected could conceivably offset the degradation of 89,839 to more than 93,306 acres of hemispherically significant wetlands, let alone thehighly significant cascading impacts to the vast array of fish and wildlife species that rely on those vital wetlands. We also note that the Corps' statement that just 7,650 acres of mitigation is required contradicts the DEIS statement that 12,583 acres of mitigation is required335—an amount that also is far too low to be able to offset impacts. The Corps' inability to meaningfully mitigate the impacts of this project is further confirmed by the Corps' failure to mitigate for the significant and longstanding adverse impacts resulting from construction at the Yazoo Pumps site completed in 1987 and from multiple other projects in the Yazoo Backwater Area. The Corps also has an extensive backlog of promised, but uncompleted, mitigation as documented in its multiple annual mitigation status reports submitted to Congress.336 For example, according to the DEIS, the Corps still must purchase and restore an absolute minimum of 1,188 acres of cleared land to offset adverse impacts from projects within the Yazoo Backwater area which will not be completed until at least 2035, and the Corps must implement an unknown amount of additional mitigation to offset levee building in the area: …the 1989 mitigation plan recommended the fee title acquisition and subsequent reforestation of 8,365 acres of cleared agricultural lands to fully offset the 526,950 annualized habitat units that were lost during the construction of the Yazoo Backwater Levees, which concluded in 1978. This construction included the right-of-way clearing of 5,900 acres of hardwoods and an additional 1,200 acres of estimated project-induced clearing that was projected to occur after levee construction.The 1989 Mitigation Plan recommended the acquisition of lands from willing sellers and identified several properties that were currently available. USACE satisfied this recommendation with the acquisition of the 8,807 acres of frequently flooded cleared lands referred to as the Lake George Property in 1990. The mitigation requirement was subsequently reanalyzed by USACE and USFWS in 2007 to account for time between when the construction of the Yazoo Backwater levee projects were completed in 1978 and when mitigation activities were initiated in 1991. Additionally, the USFWS rightfully argued that USACE had failed to properly account for the amount of acreage that was reforested at the Lake George Property. After removing acreage consisting of roads, levees, standing water, and other areas not suitable for planting, it was determined that 8,082 acres were reforested at Lake George. This reanalysis resulted in the determination that an additional 3,848 acres of mitigation was required to fully offset the construction impacts associated with the Yazoo Backwater Levees. MVK also acknowledged that it had failed to provide compensatory mitigation for the clearing of 215.2 acres at the proposed pump station site in 1987. In 2007, it was determined that an additional 519 acres of compensatory mitigation would be required to account for the impacts at the pump station and the time lost between 1987 and 2007. This left a total compensatory mitigation burden of 12,449 acres in 2007. When considering the additional 17 years between the 2007 reformulation and the present day, the current total requirement is 12,583 acres. Congressionally authorized funding for the purchase and restoration of mitigation lands has been received intermittently since 2007, and additional tracts totaling 3,313 acres have beenpurchased and reforested. To date, MVK has acquired a total of 11,395 acres of cleared agricultural lands within the Yazoo Basin to compensate for completed construction of the Yazoo Backwater Levees, leaving MVK approximately 1,188 acres short of completely fulfilling the mitigation requirements. MVK currently has funding in hand to purchase additional mitigation property, and continues to work toward satisfying the total requirement required to fully offset the impacts of previous Yazoo Backwater Levee construction. USACE estimates that these outstanding mitigation obligations will be satisfied by 2035. * * * In addition, mitigation is required for uncompleted construction within the Rocky Bayou area. MVK improved 3.7 miles of a 25-mile local levee system along with one water control structure before 1980; however, mitigation for these activities never occurred. The team is currently calculating impacts and will add the acreage to the backlog mitigation in the Final Environmental Impact Statement.337 The Conservation Organizations also note that these historic mitigation numbers likely significantly understate the actual amount of mitigation needed to fully mitigate for the "damages to ecological resources, including terrestrial and aquatic resources, and fish and wildlife losses"338 from these projects as required by law. For example, we have been advised the mitigation for the Yazoo Backwater Levee was based on the wetlands impacted by the footprint of the levee and was not based on the full suite of highly significant direct and indirect impacts.	All impacts and mitigation measures were assessed using environmental models approved for this project and agreed upon by the interagency team. The U.S. Army Corps of Engineers (USACE) believes that the document complies with the Clean Water Act, specifically 40 CFR Part 230 – Section 404(b)(1), and that it evaluates a full range of alternatives in accordance with the Clean Water Act, the National Environmental Policy Act (NEPA), and USACE regulations, policies, and guidance. Proposed mitigation addresses impacts to waters of the United States as required by Section 404 of the Clean Water Act and significant effects on fish and wildlife resources according to USACE Civil Works policy. USACE has ensured that the compensatory mitigation proposed is proportional to the unavoidable impacts and that effective safeguards are in place to guarantee mitigation success concurrent with project impacts. The Corps' mitigation approach has been refined from previous studies using advanced scientific sensors, methodologies, and decades of observations. For a detailed breakdown of the facts related to this project, the Corps invites commenters to review Appendix E-G.

Comment Number	Comment Date	Org.	Theme	Comment	Response
488	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	Mitigation	1. The DEIS Does Not Comply with Longstanding NEPA Mitigation Requirements The DEIS does not comply with longstanding NEPA mitigation requirements. As discussed throughout these comments, the DEIS does not meaningfully assess project impacts which is the fundamental first step in assessing mitigation needs.339 Instead, the DEIS fails to take any steps to assess a wide array of impacts, and drastically understates those impacts that it does consider. As a result, the DEIS does not—and cannot—comply with NEPA, which requires that the DEIS analyze mitigation measures with "sufficient detail to ensure that environmental consequences have been fairly evaluated."340 A "perfunctory description" of the mitigating measures is not sufficient.341 As the Supreme Court has noted, this is because: omission of a reasonably complete discussion of possible mitigation measures would undermine the 'action-forcing' function of NEPA. Without such a discussion, neither the agency nor other interested groups and individuals can properly evaluate the severity of the adverse effects. An adverse effect than can be fully remedied by, for example, an inconsequential public expenditure is certainly not as serious as a similar effect that canonly be modestly ameliorated through the commitment of vast public and private resources.342 The DEIS also must discuss the effectiveness of the proposed mitigation: An essential component of a reasonably complete mitigation discussion is an assessment of whether the proposed mitigation measures can be effective. The Supreme Court has required a mitigation discussion precisely for the purpose of evaluating whether anticipated environmental impacts can be avoided. A mitigation discussion without at least some evaluation of effectiveness is useless in making that determination.343 This should include a discussion of how the mitigation will effectively address temporal losses (i.e., it takes many years to restore a fully functioning, mature wetland and many decades to restore a fully functioning mature bottomland hardwood wetland forest), and how mitigation for wetland losses can be effectively carried out in areas that would be drained by the Yazoo Pumps Alternatives. A bald assertion that mitigation will be successful is not sufficient. The effectiveness must instead be supported by "substantial evidence in the record."344 A discussion of the effectiveness is particularly critical because, despite progress in this area, wetland and stream mitigation often fails or does not fully replace lost ecological values. For example, the National Research Council has concluded: "Attempts to restore forested wetlands of the Southeast (e.g., bottomland hardwoods and cypress swamps) have encountered difficulties related to the time required to replace mature trees, the lack of material to transplant, the lack of knowledge of how and when to carry out seeding or transplantation, (Clewell and Lea, 1989) and altered hydrology (drainage for conversion to agriculture) of the wetland area. Natural forested wetlands may support hundreds of plant species, many of which thrive in the understory (91 percent of 409 species in one riverine forest were understory species). Old-growth forests are dominated by trees that gradually achieve a dominant role in the canopy and that are self-sustaining through their ability to reproduce in their own shade. It is not clear that such climax species can be successfully established in open sites, or whether their introduction must await development of seral (intermediate successional stage) plant communities. Clewell and Lea (1989) noted the need for intensive site preparation to reduce competition between weeds and transplanted tree seedlings. Their review was the first to mention insect herbivory and fire as potential problems. In many cases, restoration of suitable hydrologic conditions will be necessary. The short time period within which forest restoration attempts have been monitored precludes an evaluation of their functional equivalency with natural reference systems."345 The Corps also recognizes that it is particularly difficult to mitigate adverse impacts to riverine wetlands:"Creation of riverine wetlands is difficult because rivers are highly integrated into existing landforms. Geomorphic features in particular may have required millennia to develop. Consequently, compensatory mitigation for degradation of riverine wetland functions seldom can be accomplished by creating new ones given the scarcity of appropriate sites."346 Because the DEIS does not include a meaningful discussion of mitigation or the effectiveness of the proposed mitigation, the DEIS has not taken the mandated "hard look" at the environmental impacts of the proposed action and alternatives to the action and fails to provide "a clear basis for choice among options by the decisionmaker."34	All impacts and mitigation measures were assessed using environmental models approved for this project and agreed upon by the interagency team. The U.S. Army Corps of Engineers (USACE) believes that the document complies with the Clean Water Act, specifically 40 CFR Part 230 – Section 404(b)(1), and that it evaluates a full range of alternatives in accordance with the Clean Water Act, the National Environmental Policy Act (NEPA), and USACE regulations, policies, and guidance. Proposed mitigation addresses impacts to waters of the United States as required by Section 404 of the Clean Water Act and significant effects on fish and wildlife resources according to USACE Civil Works policy. USACE has ensured that the compensatory mitigation proposed is proportional to the unavoidable impacts and that effective safeguards are in place to guarantee mitigation success concurrent with project impacts. The Corps' mitigation approach has been refined from previous studies using advanced scientific sensors, methodologies, and decades of observations. For a detailed breakdown of the facts related to this project, the Corps invites commenters to review Appendix E-G.

Comment Number	Comment Date	Org.	Theme	Comment	Response
489	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	Mitigation	The DEIS Does Not Comply with Longstanding Water Resources Development Act Mitigation Requirements The DEIS does not comply with the longstanding mitigation requirements established by the Water Resources Development Act. As discussed throughout these comments, the DEIS does not meaningfully assess project impacts which is the fundamental first step in assessing mitigation needs348 Instead, the DEIS fails to take any steps to assess a wide array of impacts. For the impacts it does consider, the DEIS drastically understates both the level and significance of the damage that will be caused and the mitigation that will be needed to offset that damage. In short, the DEIS does not assess—and has not proposed—the amount and type of mitigation that would be needed to offset the full suite of "damages to ecological resources, including terrestrial and aquatic resources, and fish and wildlife losses"349 from the Yazoo Pumps Alternatives, as required by law. Provisions established through several Water Resources Development Acts require the Corps to mitigate all losses to fish and wildlife created by a project unless the Secretary determines that the adverse impacts to fish and wildlife would be "negligible."350 As highlighted above, the DEIS does not propose enough, or the types of, mitigation needed to offset all "damages to ecological resources, including terrestrial and aquatic resources, and fish and wildlife losses."351 The Water Resources Development Acts also require the Corps to purchase mitigation lands for Corps civil works projects must be purchased before any construction begins.352 Any physical construction required for purposes of mitigation should be undertaken prior to project construction but must, at the latest, be undertaken "concurrently with the physical construction of such project."353 The DEIS makesit clear that this is extremely unlikely since it will take the Corps until at least 2035 to complete the purchase of mitigation lands for the Yazoo Backwater Levee that was completed in 1978.354 The DEIS also fails to comply with the mitigation planning requirements established by the Water Resources Development Acts. The Corps is prohibited from selecting a "project alternative in any report" unless that report includes a "specific plan to mitigate fish and wildlife losses."355 Corps mitigation plans must ensure that "impacts to bottomland hardwood forests are mitigated in-kind and harm to other habitat types are mitigated to not less than in-kind conditions, to the extent possible."356 Mitigation plans "shall include, at a minimum" each of the following components357: (1) The type, amount, and characteristics of the habitat being restored, a description of the physical actions to be taken to carry out the restoration, and the functions and values that will be achieved. (2) The ecological success criteria, based on replacement of lost functions and values, that will be evaluated and used to determine mitigation success. (3) A description of the lands and interest in lands to be acquired for mitigation, and the basis for determining that those lands will be available. (4) A mitigation monitoring plan that includes the cost and duration of monitoring and identifies the entities responsible for monitoring if it is practicable to do so (if the responsible entity is not identified in the monitoring plan it must be identified in the project partnership agreement that is required for all Corps projects). Corps mitigation must be monitored until the monitoring demonstrates that the ecological success criteria established in the mitigation plan have been met. (5) A contingency plan for taking corrective action in cases where monitoring shows that mitigation is not achieving ecological success as defined in the plan. Corps mitigation plans must also comply with "the mitigation standards and policies established pursuant to the regulatory programs" administered by the Corps.358Corps mitigation plans must also comply with "the mitigation standards and policies established pursuant to the regulatory programs" administered by the Corps.358 Corps mitigation must be monitored until the monitoring demonstrates that the ecological success criteria established in the mitigation plan have been met. The Corps is also required to consult yearly on each project with the appropriate Federal agencies and the states on the status of the mitigation efforts. The consultation must address the status of ecological success on the date of the consultation, the likelihood that the ecological success criteria will be met, the projected timeline for achieving that success, and any recommendations for improving the likelihood of success.359The DEIS Compensatory Mitigation Plan does not meet these mandatory requirements. Instead, the plan recommends a general approach that relies on a combination of flawed strategies: "The recommended plan for compensatory mitigation for the Yazoo Backwater Management Project is to pursue a combination of mitigation strategies to meet the full mitigation need and includes: • Purchase of in-kind credits from the Ducks Unlimited, Inc. Mississippi Delta In Lieu Fee Program (approved: 24 September 2010) located in the YSA if they are available. • Purchase of In-Kind Mitigation Bank Credits located in the YSA (will only meet partial mitigation needs due to the availability of credits) • Construction of a YSA specific Mitigation Project • Management of Agricultural Area Inundation for Shorebirds."360 The DEIS does not include any of the required plan components for these options. Instead, it defers all detailed planning for the in-lieu-fee and mitigation bank options to those programs, and it does not provide any of the required mitigation plan components for construction or management that would be carried out by the Corps. The DEIS does not even provide information on whether credits currently are available, or likely will be available from the identified in lieu fee program or the mitigation banks, even though this information presumably could be obtained through a few phone calls or online searches. Moreover, because specific mitigation sites have not been identified, it is not possible to determine such things as: the current conditions of the sites; whether the sites have the required hydrology to support wetland functions or have the capacity to have their hydrology restored to the point of providing meaningful wetland benefits; whether the sites will also be adversely affected by the Yazoo Pumps Alternatives; the types of actions needed to achieve mitigation success at those sites; or the degree of mitigation benefits that could be obtained from restoring those sites. Specific mitigation sites must be identified and fully evaluated before construction begins.	See response to comment 488
490	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	Mitigation	2. Pre-Disaster Mitigation and Protection Pre-disaster hazard mitigation is a highly practicable solution with a demonstrated record of reducing flood damages. On average, $1 spent on hazard mitigation through a federally funded mitigation grant saves $6 in future disaster costs. Federal grants provide $7 in benefits for each $1 invested in riverine flood mitigation. Hazard mitigation actions reduce the risk of damage from future high water events, improve community safety, increase community resilience, minimize flood disaster disruptions, and allow more rapid recovery when flooding does occur. To advance these solutions, FEMA should prioritize pre-disaster mitigation funds and assistance to Yazoo Backwater Area communities. Pre-disaster mitigation planning and funding is clearly practicable as evidenced by the many federal grant programs available to carry out this type of work and the applicable county hazard mitigation plans. The practicability of pre-disaster mitigation is also evidenced by the award of a FEMA non-financial Direct Technical Assistance Grant to the towns of Rolling Fork and Mayersville, which wasannounced on May 19, 2023. Through this grant, FEMA will provide "direct technical assistance to mitigate flood risk hazards and holistically improve the resilience of [Rolling Fork and Mayersville] through sustainable, cost-effective non-structural, natural, and nature-based measures." The practicability of implementing these types of measures through pre-disaster mitigation planning and protection is also demonstrated by the letters requesting implementation of such measures from Yazoo Backwater Area community leaders and residents. See General Comment section of these comments. The practicability of implementing these types of measures is also demonstrated by the fact that all the Yazoo Backwater Area Counties have submitted natural hazard mitigation plans to FEMA that include non-structural and natural infrastructure solutions to reduce flood risk.	See response to comment 488
491	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	Nepa	The DEIS does not include a single reference to the 2008 Clean Water Act veto that was confirmed by the U.S. Court of Appeals for the Fifth Circuit and reasserted by the Biden Administration in November 2021.7The Environmental Protection Network (EPN), an organization of over 650 U.S. Environmental Protection Agency (EPA) alumni recently advised EPA Administrator Regan that the Yazoo Pumps Alternatives "would not be allowed under the 2008 Final Determination." Several EPN members who "were actively involved in the development of the 2008 Section 404(c) Final Determination for the Yazoo River Backwater Pumps . . . helped write this letter."	EPA implements CWA section 404(c) and issued the 2008 section 404(c) Final Determination concerning the Yazoo Backwater Area Pumps Project. USACE therefore cannot speak to the applicability of EPA's Final Determination. See response to comment 5.

Comment Number	Comment Date	Org.	Theme	Comment	Response
492	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	NEPA	The DEIS, upon which the Yazoo Pumps Alternatives are based, violates multiple federal laws and policies. Among many others, the DEIS violates the 2008 Clean Water Act Veto of the Yazoo Pumps. The DEIS violates the National Environmental Policy Act (NEPA), including because the DEIS fails to include a wide array of assessments that must be carried out under NEPA. The DEIS and its Yazoo Pumps Alternatives violate the Clean Water Act 404(b)(1) Guidelines. The DEIS violates the National Environmental Policy Act (NEPA), including because the DEIS fails to include a wide array of assessments that must be carried out under NEPA. The DEIS violates the Water Resources Development Act and Clean Water Act mitigation requirements. The DEIS has not complied with the Water Resources Development Act mandatory independent external peer review requirement. The DEIS and its Yazoo Pumps Alternatives do not conform to the Federal Flood Risk Management Standard. The DEIS has not yet complied with the Endangered Species Act or the Fish and Wildlife Coordination Act. The DEIS and its Yazoo Pumps Alternatives are fundamentally at odds with the Corps' statutory "long-term goal to increase the quality and quantity of the Nation's wetlands, as defined by acreage and function."26 The DEIS and its Yazoo Pumps Alternatives are fundamentally at odds with the Administration's Freshwater Initiative which seeks to protect, restore, and reconnect 8 million acres of wetlands and 100,000 miles of our nation's river and streams by 2030.27 The complete disregard for this goals and policies is all the more unacceptable in light of the nation's alarming increase in wetland losses28 and the Supreme Court's recent decision in Sackett v. Army Corps of Engineers that has left millions of acres of wetlands without Clean Water Act protection.	EPA implements CWA section 404(c) and issued the 2008 section 404(c) Final Determination concerning the Yazoo Backwater Area Pumps Project. USACE therefore cannot speak to the applicability of EPA's Final Determination. See response to comment 5.
493	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	NEPA	The Yazoo Pumps have already been the subject of intense political pressure. Indeed, this pressure appears to have been a driving factor in this latest reassessment of the Yazoo Pumps, despite the Administration's own November 17, 2021, letter reasserting the project's long-standing Clean Water Act veto. Indeed, the Corps has already responded to pressure to lengthen the amount of time of the crop-season operating period. As documented in the DEIS, the Corps has proposed Alternative 2 in response to a push from the agricultural community during the May 2023 public engagement meetings."59 Alternative 2 initiates crop-season operations 9 days earlier than the alternative originally proposed by the Corps resulting in an additional 3,467 acres of wetland damage. Agricultural producers continue to pressure the Corps to make additional extensive changes to the operating plan, as made clear during the July 22-23 public meetings on the DEIS.60 The pressure to operate the pumps for longer periods of times and with lower pumps-on elevations continues, as was made clear during the 2024 public meetings on the Draft EIS. For example, at the July 23, 2024, 2:00 PM public meeting, members of the public called on the Corps to pump all year long61 and set the pump-on elevation even "lower."62 Indeed, the Corps explicitly solicited comments on extending the crop season through November at the July 23, 2024, 2:00 PM DEIS public hearing:"So here we get into our array of alternatives…we also look at two operational scenarios. One Alternative 2 and then Alternative 3, we're going to dive deeper into these in a second, but I'll give you a little overview. Really the difference between Alternative 2 and Alternative 3 is the growing season of the crop. Alternative 2 the crop season is 16 March through 15 October, and non-crop season of 16 October through 15 March. That's tied to elevations of when the pump could be on if there are floodwaters. We'll get into that a little deeper. But one thing that I really hope I hear comments from you guys on this is my background is agricultural economics, so I understand you guys as farmers if you grow cotton, cotton usually goes past 15 October, maybe up until November when you're harvesting after you defoliated, and go through, um, those spells. So, um, we did hear some testimony that people weren't as concerned about floodwaters in October, because it's extremely rare to see floods in the fall like that but it's something to consider and we welcome your comments on that."63 For all these reasons, the DEIS at a minimum must assess the impacts of the Yazoo Pumps Alternatives under an appropriate range of possible operating plans so decision makers and the public can properly assess the full extent of the environmental damage that could result from building the massive 25,000 cfs Yazoo Pumps. See Section C.7 of these comments for additional information on this important point	EPA implements CWA section 404(c) and issued the 2008 section 404(c) Final Determination concerning the Yazoo Backwater Area Pumps Project. USACE therefore cannot speak to the applicability of EPA's Final Determination. See response to comment 5.
494	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	Nepa	The 404(b)(1) Guidelines prohibit a discharge that will cause or contribute to violations of state water quality standards.68 As discussed in Section J and Section A of these comments, the Yazoo Pumps Alternatives will cause or contribute to violations of state water quality standards, including the state's anti-degradation policy69 and the many TMDLS for stream segments located within the Yazoo Backwater Area.	EPA implements CWA section 404(c) and issued the 2008 section 404(c) Final Determination concerning the Yazoo Backwater Area Pumps Project. USACE therefore cannot speak to the applicability of EPA's Final Determination. See response to comment 5.
495	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	nepa	The 404(b)(1) Guidelines prohibit a discharge unless "appropriate and practicable" steps have been taken to minimize potential adverse impacts on the aquatic ecosystem.71 As discussed in Sections L, M, and N of these comments—and as noted throughout these comments—the Corps has not taken appropriate and practicable steps to minimize the adverse impacts from the Yazoo Pumps Alternatives	EPA implements CWA section 404(c) and issued the 2008 section 404(c) Final Determination concerning the Yazoo Backwater Area Pumps Project. USACE therefore cannot speak to the applicability of EPA's Final Determination. See response to comment 5.
496	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	NEPA	R. The DEIS Does Not Comply with the Mandatory Independent External Peer Review Requirements Any new study must be reviewed under the Independent External Peer Review (IEPR) process required by 33 U.S.C. § 2343. IEPR is mandatory for this EIS since the Yazoo Pumps Alternatives and any variation of the Yazoo Pumps will cost well over $200 million and would unquestionably be highly controversial.444 The Yazoo Pumps Alternatives and any derivation of the Yazoo Pumps will satisfy both of the IEPR controversy triggers as: "there is a significant public dispute as to the size, nature, or effects of the project" and "there is a significant public dispute as to the economic or environmental costs or benefits of the project."445 As the Corps is well aware, "in all cases" the IEPR review must be carried out concurrently with the project study and must be completed "not more than 60 days after the last day of the public comment period for the draft project study," unless the Chief of Engineers determines that more time is necessary.446 The Corps provides IEPR plans online, and is required by law to provide the public withinformation on the timing of the IEPR, the entity that has the contract for the IEPR review, and the names and qualifications of the IEPR panel members.447 Despite these clear requirements, and repeated requests from the Conservation Organizations do to so, the Corps has not initiated the required IEPR for this project, making it impossible for the Corps to comply with this longstanding requirement in the timeline allowed by law. The Conservation Organizations once again call on the Corps to initiate the required IEPR for this project and urge the Corps to contract with the National Academies to carry out the IEPR to ensure that the review is carried out by fully independent experts with the highest possible qualifications.	See response to comment 9

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497	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	Pump operations	S. The Yazoo Pumps Alternatives Would Require New Congressional Authorization The Yazoo Pumps Alternatives vastly exceed the scope of the project's 1941 Congressional authorization so could not be built unless and until the Corps obtains new Congressional authorization. The Flood Control Act of 1941 authorized construction of the Yazoo Pumps in accordance with Plan C of the March 7, 1941, Mississippi River Commission Report.448 Plan C delimits both the capacity of the authorized pumps and the conditions of their use imposing strict limits on the project that can be built by the Corps. Plan C "assumes that pumps of about 14,000 cubic feet per second capacity would be provided to prevent the sump level from exceeding 90 feet, mean Gulf level, at average intervals of less than 5 years." Plan C also designates lands "located below 90 feet, NGVD, in elevation to serve as a sump area for surface water storage."449 The limitations established by the Yazoo Pumps authorization are extensively documented in the 2008 Clean Water Act veto.450 In 1959, the Corps determined that this authorized level of protection had been met: Since the original authorization for Yazoo Backwater Protection, important hydraulic changes have taken place due to improvement of channel efficiency in the Mississippi River and to reservoirs and channel improvement in the Yazoo Basin headwater area. These have resulted in less frequent flooding, and shorter duration of flooding, which makes it feasible to develop a simplification of the authorized plan by eliminating pumping at a large saving in project cost. . . . It is apparent that a protection plan for the Yazoo Backwater Area involving levees and floodgates only, which was not feasible under earlier conditions, is now feasible, and will provide a high degree of protection for the foreseeable future without the necessity of pumping.451 The Steele Bayou flood control structure completed in 1969 and the Yazoo Backwater Levee completed in 1978 increased that level of protection.452 Indeed, since the Yazoo Backwater Levee was completed, flooding in the Yazoo Backwater Area has been restricted to the lowest elevations. Between 1978 and 2018, water levels in the Yazoo Backwater Area never reached the 20-year floodplain and exceeded the 10-year floodplain just 2 times.453 In 2019, flooding in the Yazoo Backwater Area was predominately restricted to the 20-year floodplain—reaching just 0.23 inches above the 25-year floodplain for just 8 days before receding—even as unprecedented flooding inundated communities along the Mississippi, Missouri, and Arkansas Rivers. In 2020, flood levels in the Yazoo Backwater Area rose above the 10-year floodplain elevation for just 5 days in early March (after which levels receded for 38 days) and then again for 15 days in the second half of April.454 By comparison, flooding in the Yazoo Backwater Area reached 101.48 feet in 1973, which is well above the 100-year floodplain elevation. The Corps' 2020 Yazoo Pumps FSEIS provides further evidence that the authorized level of flood protection has been met, through its contention that the "new and more complete" period of record (1978-2019) shows that the Holly Bluff cut-off (which was completed in 1958) and the Yazoo Backwater Levee (which was completed in 1978) caused a one to three foot reduction in the 2-year floodplain elevation.455 As discussed in Section C.1, the Corps' reliance on new flood frequency elevations has the effect of reducing the number of acres categorized as "riverine wetlands" which in turn will result in a showing of fewer wetland impacts because of the Yazoo Pumps Alternatives. In the face of these significant changes in the extent of flooding and flood frequency elevation levels the DEIS should clearly explain why the Corps believes that the authorized level of flood protection (as set forth in the 1941 project authorization) has not already been achieved.On their face, the Yazoo Pumps Alternatives vastly exceed the limits imposed by the 1941 Flood Control Act. The Yazoo Pumps Alternatives propose a pumping plant with a vastly larger capacity—78% larger—than the authorized (and prohibited) 14,000 cfs pump and would drain water from areas explicitly protected by the 1941 authorization.456 Under the Yazoo Pumps Alternatives, the pumps would need to be turned on below the 90-foot-NGVD elevation during at least 7 months each year (crop season) to keep water from rising above that 90-foot elevation.	See response to comments 1, 45, 67, 90, 113, and 503

Comment Number	Comment Date	Org.	Theme	Comment	Response
498	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	threat and endangered species	The DEIS Does Not Assess Impacts to Listed Species or Critical Habitat The DEIS does not assess impacts to multiple listed species or critical habitat, which is an egregious failing. Both the DEIS (and required Biological Opinion) must fully assess the impacts to species listed and their critical habitat under the Endangered Species Act to ensure that the Yazoo Pumps Alternatives will not jeopardize listed species or adversely modify critical habitat, as required by the ESA and Clean Water Act.276 The DEIS states that the Final EIS will assess the pondberry, pallid sturgeon, fat pocketbook mussel, and Northern Long-Eared Bat which are listed as endangered, and the Alligator Snapping turtle which is being considered for listing as a threatened species under the ESA.277 However, the only analysis included in the DEIS is one for the Alligator Snapping turtle, and concerns with that analysis are discussed in Section H of these comments. The DEIS also must assess impacts to the many state listedspecies found in the Yazoo Backwater Area, including the Louisiana black bear, swallow tailed kite, peregrine falcon, Bewicks wren, pyramid pigtoe, spike, and southern redbelly dace. In its 2020 Yazoo Pumps FSEIS, the Corps claimed there was not enough data on the endangered pondberry to make an effects determination.278 This omission foreclosed the public's ability to meaningfully comment on that DEIS and violated the Corps' obligation under the ESA to ensure the proposed plan would not jeopardize the species in violation of the ESA. Yet, the Corps commits the very same error in the DEIS, acknowledging that it once again has not provided any analysis of adverse impacts to pondberry. The Corps must reinitiate formal consultation with the Fish and Wildlife Service and comprehensively assesses the impacts of all alternatives on the survival and recovery of the species, as that is essential to make an informed decision. Through that formal consultation, the Corps and the Fish and Wildlife Service must comprehensively analyze the impacts of the Preferred Alternative on the 5-year floodplain, which contains the majority of pondberry colonies in the Yazoo Backwater Area. As explained by the Fish and Wildlife Service, the pondberry is a wetland plant found in habitats that experience regular overbank flooding—such as many of the populations within bottomland hardwood forests of Mississippi.279 In the Yazoo Backwater Area, "most colonies/sites are located on the more frequently flooded 0-5 year floodplain," as shown by the Corps' data.280 The Yazoo Pumps Alternatives would significantly alter the hydrology of these sites, as highlighted by EPA in the Clean Water Act veto, documented by the Fish and Wildlife Service in the 2007 Biological Opinion, and acknowledged in the DEIS itself. Accordingly, the Corps must consider: (1) the extent to which the Yazoo Pumps Alternatives would reduce flooding in relation to baseline conditions (which must be analyzed and updated, particularly for the pondberry as discussed below); (2) the change in hydrology due to a reduction in backwater flood frequency; (3) the extent that changes in backwater flooding by the project would alter the hydrology of known sites in the Yazoo Backwater Area, including the Delta National Forest; and (4) the response of the pondberry to these hydrological changes, among other things. As part of this analysis, the Corps and the Fish and Wildlife Service must carefully identify the survival and recovery needs of the pondberry (i.e., tipping points) to evaluate whether the species will be jeopardized. A tipping points analysis is critical because the Yazoo Pumps Alternatives would significantly alter the hydrology of the Yazoo Backwater Area, degrading some of the few known remaining populations in the species' range.281 Accordingly, a tipping point analysis is essential to ensure that the Yazoo Pumps Alternatives do not push the species across the line to eventual extinction, or past a point from which recovery is impossible.Through the consultation process, the Corps and the Fish and Wildlife Service also must consider significant new information regarding the pondberry's endangered status. In 2014, the Fish and Wildlife Service undertook a 5-year review and found that "some pondberry colonies have become extirpated onthe [Delta National] Forest, while others have experienced recent declines, potentially related to stem dieback, hydrology, interspecific plant competition, and natural canopy disturbances."282 The Fish and Wildlife Service's subsequent 5-year review (completed in 2021) identified a "rapid decline" in pondberry populations on the Delta National Forest.283 The Corps must factor these recent declines into the baseline condition and evaluate the synergistic impacts of the Yazoo Pumps Alternatives on the species' survival and recovery. Furthermore, the Corps and the Fish and Wildlife Service must fully evaluate the purported severe decline in wetland acreage in the 2-year floodplain. According to the 2020 FSEIS, there has been a 1 foot to 3 foot reduction in the 2-year floodplain elevation, which has resulted in the loss of at least 96,139 acres of wetlands in the 2-year floodplain in very short period of time. According to the Notice of Intent for this DEIS, the 2-year floodplain elevation is 1.7-feet-NGVD lower than provided in the 2007 EIS, and the 5-year floodplain elevation level is 2.6-feet-NGVD lower than provided in the 2007 FSEIS.284 If these changes are indeed accurate, the Corps must assess how the lower floodplain elevations and related losses and modifications of wetland habitats have impacted pondberry colonies and the extent to which the Yazoo Pumps Alternatives could exacerbate the problem and jeopardize the species.285 This is particularly necessary given the declines in pondberry populations over this same timeframe. In addition, the Corps and the Fish and Wildlife Service must reevaluate the conservation measure proposed in the Biological Opinion. To avoid a jeopardy determination, the Corps had agreed to establish two new pondberry populations in areas where the hydrology would not be adversely affected.286 As made clear in the Fish and Wildlife Service's 5-year review, however, attempts to transplant pondberry populations have been "met with limited success."287 In Mississippi, experimental outplantings of naturally rooted pondberry stems were established at Leroy Percy State Park and Yazoo National Wildlife Refuge in Washington County as well as Hillside and Morgan Brake National Wildlife Refuges in Holmes County (Devall et al. 2004a). Survival one year after transplanting ranged from 35% to 84%. The current status of these transplants is unknown. In addition, plants cloned from populations in Sharkey and Bolivar Counties, Mississippi using micropropagation techniques (cf. Hawkins et al. 2007) were successfully transplanted to a research facility in Sharkey County (cf. Lockhart et al. 2006). This site is essentially a garden plot and well-maintained. It is unknown how these clones would perform in the wild.288This data undercuts the Corps' reliance on transplanting efforts to ensure against jeopardy to the species. As part of the consultation process, the Corps and the Fish and Wildlife Service also must address the adverse impacts of the Yazoo Pumps Alternatives on other listed or threatened species in the Yazoo Backwater Area. This assessment must, among many other things be based on: (1) An accurate assessment of the potential for the adverse impacts of the Yazoo Pumps Alternatives on the hydrology of the Yazoo Backwater Area, including the full array of impacts to wetland extent and function to wetlands (including short hydro-period wetlands) throughout the Yazoo Backwater Area. This assessment should not be artificially limited as was done in the 2007 and 2020 studies. That requires fixing the errors in the DEIS outlined above. (2) The best available scientific data on the presence and needs of listed species. For example, the 2008 Clean Water Act veto unequivocally found that the pumps would "significantly degrade critical habitat for over 40 wetland dependent bird species," including the Wood Stork289 and the Mississippi Natural Heritage Program identifies the Wood Stork as being in the region.290 However, the Corps has chosen not to review the Wood Stork in this DEIS. the Mississippi Natural Heritage Program291 and the DEIS292 also note the endangered sheepsnose and rabbitsfoot mussels are found in the region but the Corps has chosen not to review impacts to these species in the DEIS. The Corps must consider all available data to ensure that it is reviewing all listed species that could be affected by the Yazoo Pumps Alternatives. (3) A comprehensive assessment of how the elimination of critical spawning habitat, degradation of rearing habitat, and impairment of aquatic food webs will impact the host fishes for the threatened and endangered mussel species that likely inhabit the Yazoo Backwater Area. Floodplain fisheries are sustained by a network of riverine backwater wetlands293 and the Yazoo Pumps Alternatives would significantly degrade this ecosystem. The Corps must consider how loss of spawning and rearing habitat will further impact mussel species.	The taxa included in this Wildlife Appendix of the DEIS, which includes northern long-eared bats, were decided and agreed upon in conjunction with the USACE, USFWS, and EPA. That being said, Louisiana black bears were delisted in 2016 and are unlikely to rely on periodic backwater flooding above 90/93 ft in the YBA although they could be negatively impacted by widespread deep inundation flooding such as the 2019 and 2020 flood events. Southern redbelly and spike dace are associated with clear, cool, flowing streams and not with backwater flooding. Pyramid pigtoe has been determined by the USFWS to not be a distinct species but genetically the same as the more common round pigtoe and the proposed listing was withdrawn in March 2024. For the three bird species mentioned: -Swallow-tailed Kite: Is a rare transient during the post-breeding period during which backwater flooding above 90 ft rarely occurs in the YBW. -Peregrine Falcon: Transient (migration and non-breeding seasons) within the YBW and not a wetland obligate. -Bewick's Wren: Not documented in and likely does not occur in the YBW and is not a wetland obligate. See the previous response regarding the formal consultation with USFWS for pondberry. Extensive annual surveys and analyses have been conducted since the 2020 Yazoo Pumps FSEIS, which have been incorporated into a Biological Assessment that was submitted to the USFWS in July 2024. Because of the potential for unknown impacts due to changes in hydrology in some future years and corresponding changes in competing vegetation and other factors on pondberry colonies between elevations 90.0 and 93.0 NGVD, we conclude that the YBA Water Management Plan is Likely to Adversely Affect the 27 pondberry colonies (22 extant, 5 unknown status) in this elevation "effect zone." For the remaining 100 (82%) extant pondberry colonies above elevation 93.0 NGVD, we conclude that the YBA Water Management Plan is Not Likely to Adversely Affect these colonies. While the proposed Yazoo Pumps Project may adversely affect the 22 extant colonies and the 5 colonies of unknown status within the 90.0 to 93.0 ft elevation zone, these 22 extant colonies represent only 18% of known extant colonies (containing approximately 10.4% of all pondberry stems) in the YBA. Furthermore, in years that otherwise (without pumping) would have extreme and prolonged flooding during the growing season, it is possible that these 22 extant (and other at higher elevation) colonies could benefit from the pumps and this possibility may be scientifically documented if the pumps are implemented and future monitoring efforts are funded for continuation. The infrequency of backwater events, and the emerging information on local hydrographs associated with individual pondberry colonies, provide increasing evidence for the importance and role of local precipitation as a leading driver in maintaining suitable growing conditions for pondberry in the Action Area. We suggest that, within the YBA, and especially at higher elevations (i.e., above ~ elevation 95 NGVD), encroachment of palmetto into pondberry colonies, the apparent increase in wild hogs resulting in significant damage (and likely, extirpation) to many colonies, and the potential for laurel wilt disease to impact pondberry colonies in the future (at any elevation), are likely to represent more significant single and/or interacting threats and stressors to persistence of pondberry colonies than the proposed changes in hydrology in the YBA from operation of a pump station given the proposed alternatives. We reiterate the need for continued frequent monitoring of all pondberry colonies in the YBA, as well as those on private lands outside of the YBA, to monitor colony and population status, and to assess the relative impacts of identified threats. The goal should be to continue building a robust data set that, when paired with continued extensive collection of groundwater monitoring well data, will provide significant opportunities for hypotheses testing relative to the effects of annual hydrologic changes over time on pondberry colony health and persistence in the YBA. Regarding outplanting of pondberry (and other potential conservation measures), the ERDC drafted and submitted (along with the Biological Assessment) to the USFWS an ESA Section 7(a)(1) conservation plan for pondberry. This document includes multiple recommendations for better understanding (a) the short- and long-term conservation status of pondberry in the YBA, (b) extensive and long-term monitoring efforts within and outside of the YBA, (c) investigations on the impacts of multiple threats and stressors on pondberry (including hydrology, hogs, palmetto, and canopy cover), and (d) possible additional outplanting efforts.

Comment Number	Comment Date	Org.	Theme	Comment	Response
499	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	water quality	The DEIS Does Not Assess Impacts to Water Quality Within the Yazoo Backwater Area The DEIS does not assess impacts to water quality within the Yazoo Backwater Area. As a result, the DEIS does not look at such critical issues as the impacts on water quality from the degradation of 89,0000 to 93,000 acres of wetlands. The DEIS also does not assess the water quality impacts from the agricultural intensification that is a fundamental purpose of the projects. Agricultural intensification will result in even more fertilizer and pesticide applications and runoff into Yazoo Backwater Area waters.The DEIS ignores these concerns and simply assumes that pollutant levels (such as for phosphorous and nitrogen) would remain the same in the Yazoo Backwater Area. As a result, the only water quality impacts the DEIS does look at are impacts outside the Yazoo Backwater Area that would result from the discharge of the Yazoo Pumps into the Yazoo River (i.e., downstream impacts to phosphorus and nitrogen concentrations). The DEIS also fails to correct glaring deficiencies identified by the EPA regarding the discussion of dissolved oxygen levels. In 2020, the Corps suggested that a series of low flow wells would improve flow and water quality conditions in the backwater area. The EPA deemed the conclusory analysis insufficient and directed the Corps to provide information justifying its assertions.294 The DEIS fails to do so, and instead repeats verbatim the conclusory analysis of dissolved oxygen that EPA deemed inadequate.295 To comply with the Clean Water Act, the DEIS must demonstrate that the Yazoo Pumps Alternatives will not cause or contribute to violations of any applicable state water quality standard. If the Yazoo Pumps Alternatives would do so, they are prohibited by the Clean Water Act 404(b)(1) Guidelines.296 This prohibition is especially relevant as the Yazoo Backwater Area already suffers from degraded water quality due to pollutants such as sediment, pesticides, and excessive nutrients. As a result, the area includes an extensive list of section 303(d) impaired waters, some of which are subject to strict Total Maximum Daily Loads (TMDL). Furthermore, Mississippi's anti-degradation standards protect all the natural streams and wetlands in the area.297 The Yazoo Pumps Alternatives (and any derivation of the Yazoo Pumps) would exacerbate pollution levels in the Yazoo Backwater Area leading to exceedances of state water quality standards. Among other impacts, the proposed project would: (1) degrade 89,839 to more than 93,306 acres of wetlands that play a crucial role in protecting water quality; (2) increase agricultural production and the use of fertilizers and pesticides; and (3) possibly increase sedimentation in the Yazoo River. The net result could trigger exceedances of state water quality standards, and the Corps must provide "sufficient information" to conclude that this would not happen298 before it could move forward with the project. But the DEIS fails to do so.	The implementation of the 25,000 cfs Pump Station described in Alternative 2 and Alternative 3 may encourage some farmers to invest more resources into their operations for enhanced productivity of existing cultivated acres. However, agricultural acres currently in production are likely managed for maximum productivity. This operational strategy is not believed to readily translate to significant additional inputs (fertilizer, pesticides) into future farming practices as a result of the proposed pump station. Runoff from these floodplain areas above the 5-frequency should experience similar agricultural inputs to corresponding downstream reaches of the Yazoo Backwater Area. The required mitigation efforts associated with these Alternative 2 and Alternative 3 will help to offset the nutrient utilization function in the YBA by first reducing the cumulative cultivation acreage in the YBA and proportionally reestablishing trees in previously cultivated areas below 90.0 feet and 93.0 feet elevation. Alternative 2 and Alternative 3 have current mitigation acreage requirements of 7,650 ac and 5,722 ac, respectively which should serve to benefit the nutrient loading concerns for the Yazoo Backwater Area for backwater flooding in wooded areas that exceed the 5-year frequency. While the wetland filtering capacity for sediment may be reduced for floodplain areas that are inundated at the 5-year frequency or greater, required mitigation efforts should provide adequate compensation to address these concerns through reforestation. These critical DO concentrations observed in the low flow periods of the year will likely be enhanced by the implementation of the 34 supplemental low flow wells located in the headwaters of the Steele Bayou, Deer Creek, and Big Sunflower River basins. These environmental features will help to maintain base flow in the streams during critical periods minimizing pools and stagnant conditions and facilitate some reaeration through agitation. The environmental restoration feature associated with Alternative 2 and Alternative 3 promotes the construction of the supplemental low flow groundwater wells located at the headwaters of the Steele Bayou and Big Sunflower basins is expected to provide a positive benefit to the overall low DO and minimal base flow conditions observed during the critical months. These warmer months typically coincide with the low flow periods in the primary tributaries of the two basins. The supplemental water provided to increase base flow should stimulate re-aeration through agitation minimizing the presence of stagnant intermittent pools along the channels.
500	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	water quality	1. The DEIS Does Not Assess Impacts to State Water Quality Standards The Yazoo Backwater Area contains a network of streams and channels that ultimately connect through the Yazoo River to the Mississippi River near Vicksburg. Most stream flow in the Yazoo River originates in the uplands along the eastern flank of the basin and is carried to the Yazoo River via the Coldwater, Yokona, Tallahatchie, and Yalobusha Rivers, and several smaller streams. Interior drainage is providedby numerous small streams that discharge to Deer Creek, the Big Sunflower River, or Bogue Phalia, which all flow to the lower Yazoo River. Mississippi classifies all the natural streams and waters in the Yazoo Backwater Area as "Fish and Wildlife" waters, ensuring their protection under the state's anti-degradation policy.299 Fish and Wildlife waters "are intended for fishing and for propagation of fish, aquatic life, and wildlife. Waters that meet the Fish and Wildlife Criteria shall also be suitable for secondary contact recreation. Secondary contact recreation is defined as incidental contact with the water during activities such as wading, fishing, and boating, that are not likely to result in full body immersion."300 Mississippi's anti-degradation policy states that "[i]n no event . . . may degradation of water quality interfere with or become injurious to existing instream water uses."301 However, these vital waters in the Yazoo Backwater Area suffer from degraded water quality due to the impacts of agricultural past practices prevalent in the Mississippi Delta. In 2005, the state reported that overall water quality was lower in this area than anywhere else in the state, as evidenced by a region-wide advisory regarding fish consumption, including numerous consumption bans in some area waters because of high pesticide levels. EPA also documented the extensive list of 303(d)-impaired water bodies in the area in 2007 due to pollutants such as sediment, pesticides, and excessive nutrients.302 As a result, numerous waterbodies are subject to TMDLs with little or no margin for additional pollution. The Corps acknowledged in the 2007 FSEIS its obligation to analyze the TMDL and Section 303(d) list waters "because Mississippi's most recent edition of its water quality criteria states that these waters shall not be further impaired for any designated use."303 Since then, the Mississippi Department of Environmental Quality (MDEQ) has completed numerous additional TMDLs for streams and rivers in the Yazoo Backwater Area, including at least the following TMDLs: (1) Organic Enrichment / Low Dissolved Oxygen (DO) for Swiftwater Bayou Watershed (February 2014) (2) Total Nitrogen and Total Phosphorus for Silver Creek (June 2008) (3) Total Nitrogen and Total Phosphorus for Jaynes Bayou (June 2008) (4) Total Nitrogen and Total Phosphorus for Lake Jackson (June 2008) (5) Total Nitrogen and Total Phosphorus for Cypress Lake (June 2008) (6) Total Nitrogen and Total Phosphorus for Selected Large Rivers in the Delta (June 2008) (7) Yazoo River Basin Designated Oxbow Lakes for Sediment (April 2008)(8) Total Nitrogen, Total Phosphorus, and Organic Enrichment / Low Dissolved Oxygen for the False River (April 2008) (9) Yazoo River Basin Delta Region for Impairment Due to Sediment (April 2008) (10) Total Nitrogen, Total Phosphorus, and Organic Enrichment / Low Dissolved Oxygen for Deer Creek (June 2008) (11) Total Nitrogen, Total Phosphorus, and Organic Enrichment / Low Dissolved Oxygen for Snake Creek (June 2008) (12) Total Nitrogen, Total Phosphorus, and Organic Enrichment / Low Dissolved Oxygen for Collins Creek (June 2008) The DEIS must—but does not—evaluate whether the Yazoo Pumps Alternatives comply with state water quality standards, including these TMDLs.	The YBWP Area consists of three major basins: Steele Bayou, Deer Creek, and the Big Sunflower River. For the analysis of impaired water bodies, the study area was defined as the extent of the modeled 93-foot pool. As of September 2024, fifteen TMDL have been developed collectively for Deer Creek (3), the Big Sunflower River Basin (1), Steele Bayou (1), Jaynes Bayou (1), Silver Creek (1), Howlett Bayou/Cypress Bayou (1), False River (1), Cypress Lake (1), and the Yazoo River Basin (5) that apply to the Yazoo Backwater study area. Within the above TMDLs, eighteen impaired segments are located within the modeled 93-foot flood zone. These segments include reaches on Deer Creek, Big Sunflower River, Big Sunflower Diversion Channel, Steele Bayou, Jaynes Bayou, Silver Creek Howlett Bayou, Cypress Bayou, False River, Cypress Lake, Holly Bluff Cutoff, and the Yazoo River. Impairments for each listed segment vary and may be due to nutrients, organic enrichments/low dissolved oxygen (DO), DDT and toxaphene, sediment/siltation, pathogens, or biological impairment by unknown pollutants. Immediate impacts relative to the construction of the pump station could experience an increase in sediment loading on the lower segments impaired due to sediment/siltation. Impacts will be minimized through utilization of BMP's outlined in the Stormwater Prevention Plan. In addition, much of the disturbed area related to the construction site (pump pad, inlet channel, outlet channel) will be separated from Steele Bayou and the Yazoo River through the use of coffer dams. This will minimize the interaction of surface waters with run off from the construction site. These impacts will be short term, lasting until construction is completed and new vegetation can be established on disturbed areas. While the wetland filtering capacity for sediment may be reduced for floodplain areas that are inundated at the 5-year frequency or greater, required mitigation efforts should provide adequate compensation to address these concerns. The initial mitigation analysis detailed in the Mitigation Appendix J for reforestation should compensate for water quality impacts. The analysis targeted areas cleared lands at or below the 90.0 feet and 93.0 (NGVD) elevation. Reforesting existing agricultural land would benefit the Yazoo Backwater study area in two ways. Reforestation of agricultural land would remove the land from active farming, thus eliminating or reducing future applications of agricultural chemicals and fertilizers. Reforestation would also stabilize the soil increasing the overall filtering capacity of sediment, phosphorus, and legacy pesticide yield in the lower floodplain. The critical period identified for organic enrichment/low DO impairment is low-water, high-temperature periods between August and October when low DO conditions have the greatest potential for adverse effects to aquatic life. critical DO concentrations observed in the low flow periods of the year will likely be enhanced by the implementation of the 34 supplemental low flow wells located in the headwaters of the Steele Bayou, Deer Creek, and Big Sunflower River basins. These environmental features will help to maintain base flow in the streams during critical periods minimizing pools and stagnant conditions and allowing for reaeration in the base flow. Overall, the conditions that may result from the implementation of Alternative 2 and Alternative 3 with the required mitigation should help to alleviate impacts to existing water quality conditions within the study area. While the Vicksburg District is aware that the implementation of Alternative 2 and Alternative 3 has the potential to improve water quality concentrations for various parameters, it also understands that the modified water management system is limited in its ability to completely attain the water quality criteria at all times due to the modified landscape in combination with naturally occurring conditions.
501	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	water quality	2. The DEIS Does Not Assess Water Quality Impacts from Wetland Degradation Wetlands perform a series of critical functions that reduce excessive levels of pollutants. As documented by EPA, wetlands permanently remove or temporarily immobilize elements and compounds that are imported to the wetland from various sources, but primarily via the flood cycle. Elements include macronutrients essential to plant growth (e.g., nitrogen, phosphorus, and potassium) as well as heavy metals (zinc, chromium, etc.) that can be toxic at high concentrations. Compounds include pesticides and other imported materials. The primary benefit of this function is that the removal and sequestration of elements and compounds by wetlands reduces the load of nutrients, heavy metals, pesticides, and other pollutants in rivers and streams.305 Despite this critical pollutant-filtering role, the DEIS does not assess whether the impacts from the degradation of 89,839 to more than 93,306 acres of wetlands would contribute to violations of state water quality standards. As documented in the 2008 Clean Water Act veto, "the extensive loss of pollutant filtering and removal functions by wetlands impacted by the proposed project could exacerbate the elevated concentrations of the pollutants of concern, potentially causing or contributing to violations of applicable state water quality standards (40 CFR 230.10(b)).306 The DEIS must assess whether and how the extensive loss of wetland functions from the Yazoo Pumps Alternatives could exacerbate water quality degradation within the Yazoo Backwater Area and trigger violations of existing water quality standards.	The implementation of the 25,000 cfs Pump Station described in Alternative 2 and Alternative 3 differs from previous Yazoo Backwater Management Plans because it will not have an influence on the current filtering capacity of floodplains that are engaged at the 90.0 ft and 93.0 ft elevation NGVD throughout the year. The mitigation strategy associated with the current plan will also employ the Reforestation of existing agricultural land which will be targeted in area at the 90.0 ft and 93.0 elevation. This effort would benefit the Yazoo Backwater study area by removing agricultural land from active farming while concurrently employing additional reforested acres. This will help to reduce future applications of agricultural chemicals and fertilizers and would also help to stabilize the soil increasing the overall filtering capacity of sediment, phosphorus, and legacy pesticide yield in the lower floodplain.

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502	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	water quality	3. The DEIS Does Not Assess Water Quality Impacts from Agricultural Intensification A fundamental purpose of the Yazoo Pumps Alternatives is to facilitate agricultural intensification which almost certainly will result in increased use of fertilizers and pesticides, and will likely also result in increased irrigation. The net result would be unavoidable degradation of water quality, as made clear by Dr. R. Eugene Turner, one of the nation's preeminent wetland scientists. In his comments on the 2008 Clean Water Act veto, Dr. Turner clearly explained the consequences for water quality: When drained there will be substantial changes to the soils which will encourage agricultural development and this development will use fertilizers. The fertilizers will leak from the system sooner or later. Water quality compromises are, therefore, unavoidable. Several studies, for example, have demonstrated a positive linear relationships between soil P and P in runoff (Sharpley 1995; Pote et al. 1996; Davis et al. 2005). The net result is a loss in nutrient uptake/transformation, and an increase in the nutrient loading from agricultural uses of fertilizer and the 'mining' of nutrients stored in vegetation and soils (Turner and Rabalais 2003).307 The Corps must analyze whether the "net result" of the proposed alternatives—the loss of wetland capacity coupled with increased agricultural production—would impermissibly degrade waterways in the Yazoo Backwater Area or exceed TMDLs. For example, in 2006, MDEQ listed numerous rivers in the Yazoo Backwater Area as impaired for nutrients (total phosphorous and nitrogen), including Steele Bayou and the Yazoo River.308 Though the TMDL only set limits for point-sources, it acknowledged the need to assess whether these standards were sufficient, given nutrient loadings from the non-point sources, including agricultural cropland.309 Indeed, the DEIS readily acknowledges the significant increase in nutrient loading due to the shift of agricultural production and resultant increased use of fertilizers. Given the impairment of waterways due to nutrients, the Corps must demonstrate the proposed project would not cause exceedances of existing TMDLs or otherwise degrade water quality and impair existing uses in the backwater area. The Corps also has an obligation to analyze impacts of increased nutrient loadings on downstream waters, including the Gulf of Mexico.310 Each summer, an extensive area of hypoxia forms in the Gulf of Mexico as a result of high nutrients in the Mississippi and Atchafalaya Rivers. The Yazoo River basin is a significant cause of the problem due to its proximity to the Gulf and intensive agricultural operations.311 The proposed project would exacerbate this problem, requiring that the DEIS thoroughly assess thesepotential impacts to ensure that they will not cause or contribute to water quality violations downstream. The DEIS does not examine whether or how the Yazoo Pumps Alternatives would increase the total load of nitrogen in the Yazoo Backwater Area, which is subsequently discharged by the pumps into the Yazoo River (and from there to the Mississippi River). Instead, the DEIS falsely assumes that the "overall mass loading [of Nitrogen] to the Mississippi River . . . should remain approximately the same."312 But that is contradicted by the very purpose of the project. As a result, the DEIS fails to include the requisite analysis of increased loadings on water quality. The DEIS also does not examine the risks of increased irrigation because of the agricultural intensification induced by the Yazoo Pumps Alternatives. As the DEIS acknowledges, irrigation in the Yazoo Backwater Area is already contributing to extreme low flow conditions that could be greatly exacerbated by the agricultural intensification that is the primary purpose of the Yazoo Pumps Alternatives. This could have cascading adverse impacts on fish and wildlife as well. For example, agricultural irrigation already poses threats to the Yazoo Backwater Area particularly drought years, and drought has been cited as the greatest threat to the survival of the at least 33 species of mussels found in the Big Sunflower River.313 In years of worst drought conditions, mussel survey teams have found sections of rivers completely dewatered and disconnected with mussel beds fully exposed and all dead. Before drying takes place, rivers can separate into individual pools. With cessation of flow and a change from lotic to lentic conditions, high water temperatures in separated stream sections create low dissolved oxygen conditions that can kill mussels well before full drying takes place. These mass mussel die-offs in dry years, coupled with low recruitment of juvenile mussels in rivers impacted by various anthropogenic stresses makes it difficult for rare species to persist. One Big Sunflower gravel bed fully exposed in a drought can result in total mortality of a small, isolated population.	The implementation of the 25,000 cfs Pump Station described in Alternative 2 and Alternative 3 may encourage some farmers to invest more resources into their operations for enhanced productivity of existing cultivated acres. However, agricultural acres currently in production are likely managed for maximum productivity. This operational strategy is not believed to readily translate to significant additional inputs (fertilizer, pesticides) into future farming practices as a result of the proposed pump station. Runoff from these floodplain areas above the 5-year frequency should experience similar agricultural inputs to corresponding downstream reaches of the Yazoo Backwater Area. The required mitigation efforts associated with these Alternative 2 and Alternative 3 will help to offset the nutrient utilization function in the YBA by first reducing the cumulative cultivation acreage in the YBA and proportionally reestablishing trees in previously cultivated areas below 90.0 feet and 93.0 feet elevation. Alternative 2 and Alternative 3 have current mitigation acreage requirements of 7,650 ac and 5,722 ac, respectively which should serve to benefit the nutrient loading concerns for the Yazoo Backwater Area for backwater flooding in wooded areas that exceed the 5-year frequency. While the wetland filtering capacity for sediment may be reduced for floodplain areas that are inundated at the 5-year frequency or greater, required mitigation efforts should provide adequate compensation to address these concerns through reforestation. The FEIS describes the minimal impacts of DO, TN, TP, and sediment that are contributed to the Yazoo River and Mississippi River system from discharge of the Yazoo Backwater Area. The section provides comparisons of the implementation of Alternative 2 and the use of the pump station with the current conditions which employ the use of the Steele Bayou and Little Sunflower Outlet Structures only. The two scenarios compare the transfer of water from the YBA downstream to the Mississippi River. The analysis, which was calculated from the model output during a range of Mississippi River flood events (flood years 2013, 2018, and 2019) shows a slight decrease in peak loadings for the subject parameters relative to the Mississippi River when the pump station (Alternative 2) was utilized. In the pump alternative (PA) version analyzed, increases in loading to the Mississippi River from the Yazoo Backwater Area (YBA) of dissolved oxygen (DO), total nitrogen (TN), and phosphorous (TP) peak at a range of 1.5-3.1%, 2.5-5.8%, and 3.0-5.5%, respectively. Alternately, in the without pump (WOP) version analyzed, increases in loading to the Mississippi River from the YBA of DO, TN, and TP peak at a range of 2.3-5.8%, 3.7-6.2%, and 3.6-7.0%, respectively. By comparison, the PA version delivers a smaller percentage increase of DO, TN, and TP of peak loading to the existing capacity in the Mississippi River as calculated during the labeled flood events. Since the overall mass of TN and TP remains unchanged in the YBA, the reduction in peak loading is accomplished by extending the flood event from 2 to 5 weeks on the leading edge of a given flood event. With current conditions, loading is delivered to the Mississippi River in a "plug flow" style. The pump creates both more time to distribute load to the Mississippi River and more consistent flow from the Backwater Area to the Mississippi River.
503	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	Wetlands	Alternative 2 would damage at least 93,306 acres of wetlands—an area of wetlands twice as large as Washington D.C.; 3.3 times larger than the Clean Water Act veto trigger; and more than 10 times the wetland impacts of all other Clean Water Act vetoed projects combined.4 • Alternative 3 would damage at least 89,839 acres of wetlands—an area of wetlands twice as large as Washington D.C.; 3.2 times larger than the Clean Water Act veto trigger; and more than 9.6 times the wetland impacts of all other Clean Water Act vetoed projects combined.The DEIS also takes great pains to hide the massive acreage of wetlands that will be damaged by the project. The DEIS Main Report does not provide information on wetland acres damaged. Instead, the information—which confirms the Yazoo Pumps Alternatives would cause significant adverse impacts in violation of the veto—is buried on page 87 of the Wetland Appendix F-3 (Table 53). The Corps also has not provided any information on the extent of wetland damage during the public meetings attended by members of the Conservation Organizations and has not included this information in the project overview slides posted on the Corps' project website	The proposed Alternatives 2 and 3 would allow for backwater flood events to reach the entirety of the 5-year floodplain during the non-crop season in years when flood elevations on the Mississippi River necessitate closure of the downstream water control structures (e.g., Steele Bayou) and sufficient precipitation occurs within the Yazoo Backwater Area to induce a 5-year flood event. Additionally, these alternatives allow wetland hydrology to persists within the 2-year floodplain throughout the crop season when the conditions noted above occur. The estimated impacts to wetlands were derived using an established, certified, data-driven approach that has repeatedly been shown to effectively link remote sensing and ground-based measurements with wetland functions. The analysis was conducted using the assumptions that all areas subject to as little as one day of flood inundation are functioning as wetlands and that all non-agriculture lands experiencing flooding are highly functional mature forested wetlands. The extensive monitoring and adaptive management plan will include long-term monitoring of conditions within the study area to ensure that 1) impacts to wetlands were not underestimated, 2) any potential unanticipated impacts to wetlands can be quantified and addressed, and 3) the establishment of wetland mitigation successfully offsets impacts to wetlands resulting from project implementation. Subject matter experts involved with the analysis of potential wetland impacts were present at the public meetings, and engaged with the public and other stakeholders regarding the wetland assessment and associated outcomes. The selected approach along with the considerations noted above promotes the responsible management of the valuable wetland resources in the Yazoo Backwater Area.
504	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	wetlands	The adverse implications of the full array of direct and indirect impacts will be amplified by the already highly significant loss and degradation of the wetlands in the Yazoo Backwater Area and the Mississippi Delta. The adverse implications of these already unacceptable adverse impacts will be further amplified by a range of other significant cumulative impacts, including that the Lower Mississippi Alluvial Valley has already lost 80 percent of its original wetlands. The majority of those losses have been traced directly to the effects of federal flood control and drainage projects.38 From just the 1970s to 2006, the Yazoo Backwater Area lost 11 percent of its remaining forested wetlands.39 The loss and/or degradation of many tens of thousands of additional acres of wetlands from the Yazoo Pumps Alternatives wouldhave catastrophic implications for the ecology of the Lower Mississippi Alluvial Valley and for the fish and wildlife that rely on those resources. For some species, the Yazoo Pumps Alternatives could be the proverbial straw that breaks the camel's back pushing species to or past their tipping points.	The proposed Alternatives 2 and 3 would allow for backwater flood events to reach the entirety of the 5-year floodplain during the non-crop season in years when flood elevations on the Mississippi River necessitate closure of the downstream water control structures (e.g., Steele Bayou) and sufficient precipitation occurs within the Yazoo Backwater Area to induce a 5-year flood event. Additionally, these alternatives allow wetland hydrology to persists within the 2-year floodplain throughout the crop season when the conditions noted above occur. The estimated impacts to wetlands were derived using an established, certified, data-driven approach that has repeatedly been shown to effectively link remote sensing and ground-based measurements with wetland functions. The analysis was conducted using the assumptions that all areas subject to as little as one day of flood inundation are functioning as wetlands and that all non-agriculture lands experiencing flooding are highly functional mature forested wetlands. The extensive monitoring and adaptive management plan will include long-term monitoring of conditions within the study area to ensure that 1) impacts to wetlands were not underestimated, 2) any potential unanticipated impacts to wetlands can be quantified and addressed, and 3) the establishment of wetland mitigation successfully offsets impacts to wetlands resulting from project implementation. The selected approach along with the considerations noted above promotes the responsible management of the valuable wetland resources in the Yazoo Backwater Area.
505	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	Wetlands	The DEIS shows that the pumps would be turned on when water levels are below 91 feet at least 82% of the time that they are used (18 out of the 22 times that the pumps would have been used over the period of record analyzed in the DEIS). Because the Yazoo Pumps Alternatives have a 78% larger pumping capacity than the 14,000 cfs pumping plant analyzed in the Clean Water Act veto, the Yazoo Pumps Alternatives will cause far more harm to wetland functions. The Corps has made much of the fact that its operating plan was designed to reduce flood risks while reducing environmental impacts. But the proposed operating plans miss the point of the veto as those plans fail to address the unacceptable adverse impacts of operating the pumps during the spring breeding and rearing season. Indeed, instead of avoiding those impacts, the Corps has made the problem worse by proposing to operate significantly larger 25,000 cfs pumps during this critical timeframe. The Conservation Organizations also point out that proposed operating plans are focused entirely on benefitting industrial-scale agriculture as pumping below the prohibited 90-foot elevation—i.e., below the 2-year floodplain—is triggered by crop season. Indeed, the only difference between the operating plans for Alternatives 2 and 3 is a slight variation on the crop-season start date. During non-crop season, water levels will be allowed to reach the 93-foot elevation—i.e., the 5-year floodplain. As documented in the DEIS, even small changes in the operating regime can translate into significant additional harm. For example, Alternative 2 includes 9 extra days of pumping below the 90-foot elevation as compared to Alternative 3. But these 9 extra days result in an additional 3,467 acres of wetland damage.48	The proposed Alternatives 2 and 3 would allow for backwater flood events to reach the entirety of the 5-year floodplain during the non-crop season in years when flood elevations on the Mississippi River necessitate closure of the downstream water control structures (e.g., Steele Bayou) and sufficient precipitation occurs within the Yazoo Backwater Area to induce a 5-year flood event. Additionally, these alternatives allow wetland hydrology to persists within the 2-year floodplain throughout the crop season when the conditions noted above occur. The estimated impacts to wetlands were derived using an established, certified, data-driven approach that has repeatedly been shown to effectively link remote sensing and ground-based measurements with wetland functions. The analysis was conducted using the assumptions that all areas subject to as little as one day of flood inundation are functioning as wetlands and that all non-agriculture lands experiencing flooding are highly functional mature forested wetlands. The extensive monitoring and adaptive management plan will include long-term monitoring of conditions within the study area to ensure that 1) impacts to wetlands were not underestimated, 2) any potential unanticipated impacts to wetlands can be quantified and addressed, and 3) the establishment of wetland mitigation successfully offsets impacts to wetlands resulting from project implementation. The selected approach along with the considerations noted above promotes the responsible management of the valuable wetland resources in the Yazoo Backwater Area.

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506	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	Wetlands	In addition to being prohibited by the Clean Water Act 404(c) veto, the Yazoo Pumps Alternatives are prohibited by the Clean Water Act 404(b)(1) Guidelines. The 404(b)(1) Guidelines strictly prohibit a "discharge into the aquatic ecosystem unless it can be demonstrated that such a discharge will not have an unacceptable adverse impact either individually or in combination with known and/ or probable impacts of other activities affecting the ecosystem of concern."64 The "degradation or destruction of special aquatic sites, such as filling operations in wetlands, is considered to be among the most severe environmental impacts covered by the[] Guidelines."65 These Guidelines are binding and are explicitly applicability to water resources projects planned or constructed by the Corps.66 The Yazoo Pumps Alternatives are prohibited because: (1) They Will Contribute to Significant Degradation of Waters of the United States The 404(b)(1) Guidelines prohibit discharges that "will cause or contribute to significant degradation of the waters of the United States."67 The Yazoo Pumps Alternatives will unquestionably contribute to significant degradation, and thus are prohibited. As discussed above, the DEIS acknowledges that Alternative 2 would damage at least 93,306 acres of wetlands and Alternative 3 would damage at least 89,839 acres of wetlands. As also discussed above, it its 2008 Clean Water Act, EPA already determinedthat impacts at this scale would cause unacceptable adverse impacts to hemispherically significant wetlands. Notably, EPA has used its veto authority sparingly to stop only those projects that would cause the worst of the worst impacts.	The agencies are coordinating to ensure that all requirements of Clean Water Act 404(c) and the Clean Water Act 404(b)(1) Guidelines are addressed along with the concerns highlighted in the Clean Water Act 404(c) veto. The proposed Alternatives 2 and 3 seek to reduce potential wetland impacts by allowing for backwater flood events to reach the entirety of the 5-year floodplain during the non-crop season in years when flood elevations on the Mississippi River necessitate closure of the downstream water control structures (e.g., Steele Bayou) and sufficient precipitation occurs within the Yazoo Backwater Area to induce a 5-year flood event. Additionally, these alternatives allow wetland hydrology to persists within the 2-year floodplain throughout the crop season when the conditions noted above occur. The estimated impacts to wetlands were derived using an established, certified, data-driven approach that has repeatedly been shown to effectively link remote sensing and ground-based measurements with wetland functions. The analysis was conducted using the assumptions that all areas subject to as little as one day of flood inundation are functioning as wetlands and that all non-agriculture lands experiencing flooding are highly functional mature forested wetlands. The extensive monitoring and adaptive management plan will include long-term monitoring of conditions within the study area to ensure that 1) impacts to wetlands were not underestimated, 2) any potential unanticipated impacts to wetlands can be quantified and addressed, and 3) the establishment of wetland mitigation successfully offsets impacts to wetlands resulting from project implementation. The selected approach along with the considerations noted above promotes the responsible management of the valuable wetland resources in the Yazoo Backwater Area.
507	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	Wetlands	Understanding the full extent of wetland impacts is critically important because the Yazoo Pumps would drain an area that: contains some of the richest natural resources in the nation including a highly productive floodplain fishery, one of only a few remaining examples of the bottomland hardwood forest ecosystem which once dominated the Lower Mississippi Alluvial Valley, and is one of only four remaining backwater ecosystems with a hydrological connection with the Mississippi River."74 Forested wetlands have long been recognized as vitally important and as being "among the Nation's most important wetlands."75 As the 2008 Clean Water Act veto makes clear, construction and operation of the Yazoo Pumps "would dramatically alter the timing, and reduce the spatial extent, depth, frequency, and duration of time that wetlands within the project area are inundated."76 The ecological implications of these changes are enormous, because hydrology is "the single most important determinant of the establishment and maintenance of specific types of wetlands and wetland processes."77 Among many other things: Hydrology affects species composition and richness, primary productivity, organic accumulation, and nutrient cycling in wetlands. . . . Water depth, flow patterns, and duration and frequency of flooding, which are the result of all the hydrologic inputs and outputs, influence the biochemistry of the soils and are major factors in the ultimate selection of the biota of wetlands. . . . the hydrology of a wetland directly modifies and changes its physiochemical environment (chemical and physical properties), particularly oxygen availability and related chemistry, such as nutrient availability, pH, and toxicity (e.g., the production of hydrogen sulfide). Hydrology also transports sediments, nutrients, and even toxic materials into wetlands, thereby further influencing the physiochemical environment. . . . Hydrology also causes water outflows from wetlands that often remove biotic and abiotic material, such as dissolved organic carbon, excessive salinity, toxins, and excess sediments and detritus."78Critically, even small alterations in wetland hydrology can produce significant, ecosystem-wide changes, as the seminal textbook on wetlands makes clear: When hydrologic conditions in wetlands change even slightly, the biota may respond with massive changes in species composition and richness and in ecosystem productivity.79 Wetlands maintained by overbank flooding are particularly productive: "Pulse-fed wetlands are often the most productive wetlands and are the most favorable for exporting materials, energy, and biota to adjacent ecosystems."80 The Corps recognizes that pulse-fed riverine wetlands provide at least three critical functions (detaining floodwater, exporting organic carbon, and removing elements and compounds) that are not provided by non-riverine wetlands.81 Riverine wetlands provide essential habitat for many species of fish and wildlife, including critical spawning habitat.82 The hydrological cycle of overbank flooding that is well recognized as being "critically important to maintenance of project-area wetland and aquatic habitat values, including fisheries production" and that provides the biochemical link to the rest of the lower Mississippi Alluvial Valley ecosystem.83 Understanding the full spatial extent of wetland impacts and full extent of impacts to wetland functions is fundamental to understanding the full extent of impacts from the Yazoo Pumps Alternatives, including because the Yazoo Pumps Alternatives would diminish the hydrologic cycle that produces overbank flooding throughout the year. If the DEIS understates wetland impacts, those flaws infect the entire impacts analysis and magnify the unreliability of the DEIS. The Conservation Organizations note that the DEIS analysis of wetland impacts, and thus the entire DEIS impacts analysis, is based on the hydrologic modeling discussed in the DEIS Engineering Report.84 Despite the foundational and fundamental role of this modeling in the DEIS, the Engineering Report provides relatively little information to explain the model or its outputs. Consequently, the Conservation Organizations were compelled to request the underlying model, model inputs, and model outputs through the Freedom of Information Act. Despite two such requests85, and	The selected wetland assessment approach accounts for the individual wetland functions referenced in this comment, ensuring that potential impacts to plant and animal species, the retention of floodwater, the export of organic carbon, etc are properly quantified. The estimated impacts to wetlands were derived using an established, certified, data-driven approach that has repeatedly been shown to effectively link remote sensing and ground-based measurements with wetland functions. The analysis was conducted using the assumptions that all areas subject to as little as one day of flood inundation are functioning as wetlands and that all non-agriculture lands experiencing flooding are highly functional mature forested wetlands. The extensive monitoring and adaptive management plan will include long-term monitoring of conditions within the study area to ensure that 1) impacts to wetlands were not underestimated, 2) any potential unanticipated impacts to wetlands can be quantified and addressed, and 3) the establishment of wetland mitigation successfully offsets impacts to wetlands resulting from project implementation. The monitoring will include an unprecedented array of shallow groundwater wells to quantify changes in wetland hydrology, along with repeated measurements of wetland functional capacity. The selected approach along with the considerations noted above promotes the responsible management of the valuable wetland resources in the Yazoo Backwater Area.

Comment Number	Comment Date	Org.	Theme	Comment	Response
508	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	Wetlands	The DEIS Does Not Utilize the Appropriate Period of Record for Determining Flood Frequency and Wetland Classification As highlighted in the Corps' own 2013 HGM Regional Guidebook, the Corps should establish the riverine wetland baseline by using flood frequency conditions present in the mid-twentieth century (i.e., the 1950s) for categorizing wetland classes, for determining flow frequencies, and for assessing wetland impacts (including loss of functionality):86 As with the classification system, flood frequencies established as a result of the major river engineering projects in the mid-twentieth century are considered to be the baseline condition in most assessment scenarios.87 As a result, the Corps should not rely on changes to flood frequencies, inundation patters, or wetland classification criteria resulting from construction and operation of the Yazoo Backwater Levee (completed in 1978), the Steele Bayou water control structure; (completed in 1969), Little Sunflower River water control structure (completed in 1975), and Muddy Bayou water control structure (completed in 1978) or other post-1950s Yazoo Backwater Area flood projects. Riverine wetlands that were subject to flooding once every 5-years on average and that otherwise met the wetland definitional criteria prior to these more recent flow alteration projects must still be categorized as riverine wetlands for purposes of assessing impacts, even if wetlands are degraded. Fully assessing the adverse impacts to the riverine class of wetlands is essential as those wetlands provide an array of critical functions not provided by other wetland classes, as discussed below. Impacts to riverine wetlands are also particularly difficult to mitigate, as recognized by the Corps: "Creation of riverine wetlands is difficult because rivers are highly integrated into existing landforms. Geomorphic features in particular may have required millennia to develop. Consequently, compensatory mitigation for degradation of riverine wetland functions seldom can be accomplished by creating new ones given the scarcity of appropriate sites."88 The DEIS fundamentally ignores its own HGM Regional Guidebook, choosing instead to rely on flood frequencies based on a period of record that begins in 1978—after completion of each of the large-scale projects highlighted about that individually and collectively fundamentally altered hydrologic conditions and flood frequency elevations. Indeed, the flood frequency elevations used in the DEIS are significantly lower than the ones used in the 2007 EIS:The 2-year (50 percent ACE) floodplain elevation is 89.3-feet-NGVD.89 This is 1.64-feet-NGVD lower than the 91-foot-NGVD 2-year floodplain elevation in the 2007 EIS.90 • The 5-year (20 percent ACE) elevation is 92.0-feet-NGVD.91 This is 2.6-feet-NGVD lower than the 94.6-foot-NGVD 5-year floodplain elevation in the 2007 EIS.92 Relying on this new flood frequency elevations has the effect of reducing the number of acres categorized as "riverine wetlands" which in turn will result in a showing of fewer wetland impacts because of the Yazoo Pumps Alternatives. The Conservation Organizations also note that it is essential that the DEIS utilize accurate flood frequency elevation levels consistently for all analyses in the DEIS. Accurate and consistent stage elevations are essential for multiple analyses, including the assessment of wetland and stream impacts, project need, project benefits, and mitigation feasibility and costs. If the flood frequency elevations are lower now than they were in 2007, those reductions will have resulted in adverse impacts to Yazoo Backwater Area streams, wetlands, and wildlife that must be fully accounted for including through a meaningful assessment of cumulative impacts. The Corps also may not properly limit the application of a lower flood frequency elevation to assess wetland and other impacts without also applying that lower flood frequency elevation to assess project need and project benefits. Notably, if the flood frequency elevations are in fact lower now than they were in 2007, the areas at risk of flooding in the Yazoo Backwater Area would also be smaller now, which must be factored into the assessment of project need. If a smaller area in the Yazoo Backwater Area is now at risk of flooding without the Yazoo Pumps Alternatives, the areas that could potentially benefit from the Yazoo Pumps Alternatives will also be smaller—which means that the benefits will be smaller as well. Notably, the DEIS also must explain why, in the face of these significant changes in flood elevation, the authorized level of flood protection (as set forth in the 1941 project authorization) has not already been achieved. Additional information on this important issue is provided in Section S of these comments.	While the current assessment did not utilize the 2013 HGM Regional Guidebook, but applied the Yazoo Basin-specific guidebook described in Smith and Klimas (2002). However, the 2013 Guidebook seeks to communicate that users should not consider conditions prior to the establishment of the 'mainstem Mississippi River levee and related systemic flood-control features' when determining baseline conditions. When conducting HGM wetland assessments in the region the presence of the levees represents the baseline conditions and users should not determine the VFREQ - Change in Flood Frequency based on pre-levee construction conditions. That variable is not used in the current assessment, which instead uses the estimated flood frequency to generate a number of the wetland functional capacity index scores. Regardless the Yazoo Backwater levee and the other measures included in the comment are permanent features and play a role in the larger Mississippi River and Tributaries systemic flood-control program. The presence the features is therefore considered to be the baseline condition within the project area for the application of the HGM wetland assessment approach. In response, the wetland analysis used data from the post-Yazoo flood risk feature period (i.e., the baseline condition) to determine wetland impacts across the extent of the 5-year floodplain. Available data does not suggest that fewer wetlands were assessed during the current study. A comparison between the analysis conducted in 2007 and the current report indicates that an additional 2430 acres of wetlands were assessed within the 2-year floodplain during the current assessment. Additionally, the analysis was conducted using the assumptions that all areas subject to as little as one day of flood inundation are functioning as wetlands and that all non-agriculture lands experiencing flooding are highly functional mature forested wetlands. The extensive monitoring and adaptive management plan will include long-term monitoring of conditions within the study area to ensure that 1) impacts to wetlands were not underestimated, 2) any potential unanticipated impacts to wetlands can be quantified and addressed, and 3) the establishment of wetland mitigation successfully offsets impacts to wetlands resulting from project implementation. The monitoring will include an unprecedented array of shallow groundwater wells to quantify changes in wetland hydrology, along with repeated measurements of wetland functional capacity. The selected approach along with the considerations noted above promotes the responsible management of the valuable wetland resources in the Yazoo Backwater Area.

Comment Number	Comment Date	Org.	Theme	Comment	Response
509	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	Wetlands	2. The DEIS Improperly Limits the Spatial Extent of Its Wetland Impacts Analysis While the DEIS has properly expanded its assessment of wetland impacts to include the 5-year floodplain, it is still artificially constraining the spatial extent of its wetland impacts analysis. The DEIS may not limit its analysis of wetland impacts in this way, instead it must analyze wetland impacts wherever those impacts occur—whether above or below the 5-year floodplain elevation.93Analyzing the full extent of wetland impacts is required to properly identify the least environmentally damaging alternative, as required by the Clean Water Act 404(b)(1) Guidelines; and for properly avoiding, minimizing, and mitigating for wetland, stream, and fish and wildlife impacts as required by the Clean Water Act and 33 USC § 2283. Importantly, analyzing the full extent of wetland impacts—whether above or below the 5-year floodplain elevation is explicitly supported by the Corps' Corps' own HGM Guidebooks.94,95 For example: (1) The July 2013 Regional Guidebook makes clear that any category of wetlands can, and do, occur above the 5-year return interval and that reliance on the 5-year return interval as the demarcation line for the riverine wetland subclass is just a rule of thumb. For example, as highlighted below the guidebook makes it clear that "all connected wetlands are assumed to be fully functional" where the frequency of flooding variable is used.96 The guidebook also makes it clear that part of the reason the Corps' selected the 5-year return interval had nothing to do with wetland functions: This [5-year] return interval is regarded as sufficient to support major functions that involve periodic connection to stream systems. It was also selected as a practical consideration, because the hydrologic models used to develop flood return interval maps generally include the 5-year return interval.97 (2) The July 2013 Regional Guidebook makes clear that "all connected wetlands are assumed to be fully functional" where the frequency of flooding variable is used.98 As discussed in Section G.2 of these comments, the many hydrological connections and mechanisms by which streams and wetlands, singly or in aggregate, affect the physical, chemical, and biological integrity of downstream waters are documented in the EPA report entitled Connectivity of Streams and Wetlands to Downstream Waters: A Review and Synthesis of the Scientific Evidence.99 For example, as recognized in the July 2013 Regional Guidebook HGM regional guidebook, many of the region's wetlands are connected through the shallow alluvial aquifer.100 This aquifer "is a significant component of the hydrology of the [Mississippi Alluvial Valley]" that is "recharged by surface water."101 "Generally, the surface of the alluvial aquifer is within 10 m of the land surface"102 and it "is essentially continuous thorough the Mississippi Alluvial Valley."103 According to the guidebook, both subclasses of "flat" wetlands, which are the classification ofwetlands that are principally sustained via precipitation with little to no surface or subsurface connections, "are not common in the [Mississippi Alluvial Valley]." 104 A 2008 independent hydrologic study also highlights this connectivity, highlighting that wetlands "across the Yazoo River basin [are] characterized by extremely flat topographic surface water connections and mosaics of complex drainage patterns."105 Critically, that study found that the Corps' failure to account for these critical connections caused the Corps to understate the impacts of the 14,000 cfs pumps recommended by the Corps in 2007 by a massive 37,000 acres. Accounting for those connections showed that the pumps would drain "37,000 acres of jurisdictional wetlands in addition to the 26,300 acres reported by the USACE."106 (3) The 2013 HGM Regional Guidebook makes clear that riverine wetlands that have been degraded due to flow alterations caused by flood control and drainage projects must still be classified as "riverine wetlands" (and assessed), even if they fall outside the area with a 20-percent annual chance of flooding,107 as discussed above. (4) The 1995 HGM Riverine Guidebook does not rely on a specific flood-return interval for classifying a riverine wetland but instead evaluates the geomorphic setting and water sources to determine the appropriate wetland class. This guidebook states that riverine wetlands are "a class of wetlands that has a floodplain or riparian geomorphic setting" and are sustained by a ratio of more than 33-percent surface flow more than 33-percent groundwater, and less than 33-percent precipitation. The guidance highlights that this ratio is not distinct, but is instead a gradient, and that gradients between wetland classes are "continuous".108 Critically, the Corps' reliance on the post-1978 period of record to establish the new flood frequency elevations highlighted above, also translates into an inappropriate reduction in the spatial extent of the Corps' wetland impact assessment. If these changes are accurate (and our organizations note that the Corps has provided any evidence to support these "new" elevations), they indicate that flooding is occurring less frequently than it did in the past—i.e., less frequently than it did under the period of record used for the 2007 EIS—and that the area within the 5-year floodplain (20-percent ACE) is also smaller than it was in the past. If the Corps follows its typical, incorrect practice of only considering riverine wetland impacts within the 5-year floodplain, the "new" elevations also would translate into the Corps looking at a much smaller area for assessing riverine wetland impacts. "According to the Corps, the Yazoo Backwater Area contains between 150,000 to 229,000 acres of wetlands."109 Since, as acknowledged in the Corps' 2013 HGM Regional Guidebook, most of these wetlands are connected via surface or subsurface flow, draining water from the lower elevations will inevitably impact wetlands at higher elevations as gravity pulls water down from the higher to the lower elevations. This will inevitably cause connected wetlands at higher elevations to change due to the new	The agencies are coordinating to ensure that all requirements of Clean Water Act 404(c), the Clean Water Act 404(b)(1) Guidelines, etc are addressed. The analysis was limited to the 5-year floodplain because that defines the extent of riverine wetlands within the region. Flooding within the 5-year floodplain is regarded as sufficient to support major functions that involve periodic connection to stream systems. While wetlands occur above the 5-year floodplain, the ecological functions provided by those wetlands are not dominated by riverine processes and therefore would not be impacted by project implementation. The wetland hydrology in those areas is derived predominantly from precipitation, groundwater, and localized runoff. The reference to the quoted text in the 2013 document "all connected wetlands are assumed to be fully functional" is only applicable to those areas within the 5-year floodplain and the VFREQ variable is not applied to wetlands outside of the 5-year floodplain. Additionally, the analysis was conducted using the assumptions that all areas subject to as little as one day of flood inundation are functioning as wetlands and that all non-agriculture lands experiencing flooding are highly functional mature forested wetlands. The extensive monitoring and adaptive management plan will include long-term monitoring of conditions within the study area to ensure that 1) impacts to wetlands were not underestimated, 2) any potential unanticipated impacts to wetlands can be quantified and addressed, and 3) the establishment of wetland mitigation successfully offsets impacts to wetlands resulting from project implementation. The monitoring will include an unprecedented array of shallow groundwater wells to quantify changes in wetland hydrology, along with repeated measurements of wetland functional capacity. The selected approach along with the considerations noted above promotes the responsible management of the valuable wetland resources in the Yazoo Backwater Area.
510	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	Wetlands	3. The DEIS Does Not Properly Account for Lost Wetland Functions In addition to accurately assessing the spatial extent of wetland and stream impacts, the DEIS must accurately assess the loss or modification of wetland functions and the ecological implications of those changes. This is particularly critical for the DEIS, as the Yazoo Pumps are specifically designed to reduce, eliminate, and otherwise modify overbank flooding. The DEIS does not properly account for lost wetland functions, including by relying on approaches explicitly rejected in the Clean Water Act veto. For example: (a) The DEIS sums the HGM assessments of eight functional capacity units110 that will be affected by the Yazoo Pumps Alternatives to determine the amount of functions capacity units that would be lost per habitat unit due to the Yazoo Pumps Alternatives and for determining the amount of functions capacity units that would be gained per habitat unit through mitigation.111 However, this approach was explicitly rejected in the 2008 Clean Water Act veto because it can obscure significant losses of individual functions and suggest that mitigation can be achieved by offsetting one function with another different function.112 (b) The DEIS HGM assessment assumes that vegetative composition in the Yazoo Backwater Area wetlands will remain essentially static overtime,113 even though slight changes in wetland hydrology can cause "massive changes in [plant and animal] species composition and richness and in ecosystem productivity."114 However, this approach was rejected by EPA as invalid in the Clean Water Act veto.115It is critical that the DEIS comprehensively examine the ecological implications of the impacts of the Yazoo Pumps Alternatives, including by far more carefully assessing the ecological impacts resulting from such things as: • Eliminating, reducing, or otherwise modifying overbank flooding at the times, depths, and durations needed to sustain healthy populations of fish and wildlife. • Undermining flood storage capacity by reducing the ability of the area's wooded wetlands to store floodwaters, reduce flood peaks, modify peak travel time.116 • Undermining nutrient and sediment removal capabilities since "reconnection of bottomland hardwood wetlands to their surrounding watershed through the restoration of surface hydrology is necessary to restore wetland functions important to nutrient and sediment removal."117 • Causing potentially "massive changes in species composition and richness and in ecosystem productivity."118 • Further depleting the already significant low stream flows in the Yazoo Backwater Area and the significantly depleted groundwater in the Mississippi Delta by impacting large swaths of wetlands that contribute to the protection and restoration of stream flow and groundwater recharge.	The agencies are coordinating to ensure that all concerns highlighted in the 2008 CWA veto. The assessment made the assumption that all non-agricultural potential wetland areas in the 5-year flood were mature highly functional forested wetlands. This assumption accounts for any unanticipated shifts in vegetation composition. Additionally, the summation of wetland functional capacity units is one of the recommended approaches to conducting HGM analyses (Smith et al 2013), and established mitigation areas demonstrate that an array of wetland functions result from afforestation of agricultural lands on hydric soils. The estimated impacts to wetlands were derived using an established, certified, data-driven approach that has repeatedly been shown to effectively link remote sensing and ground-based measurements with wetland functions. The analysis was conducted using the assumptions that all areas subject to as little as one day of flood inundation are functioning as wetlands and that all non-agriculture lands experiencing flooding are highly functional mature forested wetlands. The extensive monitoring and adaptive management plan will include long-term monitoring of conditions within the study area to ensure that 1) impacts to wetlands were not underestimated, 2) any potential unanticipated impacts to wetlands can be quantified and addressed, and 3) the establishment of wetland mitigation successfully offsets impacts to wetlands resulting from project implementation. The monitoring will include an unprecedented array of shallow groundwater wells to quantify changes in wetland hydrology, along with repeated measurements of wetland functional capacity. The selected approach along with the considerations noted above promotes the responsible management of the valuable wetland resources in the Yazoo Backwater Area.

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511	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	Wetlands	The DEIS Does Not Assess Impacts to Wetland Plants Despite acknowledging the importance of wetland plant species, the DEIS does not assess the impacts of the Yazoo Pumps Alternatives on wetland plant species and plant species composition. The DEIS also does not assess the cascading impact to fish and wildlife from these flora changes. The DEIS does not assess impacts to wetland plants. Instead, the DEIS improperly assumes that wetland plant communities will remain relatively static despite the significant impacts of the Yazoo Pumps Alternatives, as discussed above. The failure to assess impacts to wetland plants and plant communities is a fundamental flaw in the DEIS given the essential role that those plant communities have in supporting and maintaining fish and wildlife and other critical wetland functions. The failure to assess plant impacts is also unacceptable because as it is well recognized that even slight changes in wetland hydrology—which will unquestionably occur as a result of the Yazoo Pumps Alternatives—can cause "massive changes in [plant and animal] species composition and richness and in ecosystem productivity."119 While it is critical to assess the impacts of the Yazoo Pumps Alternatives on the federally endangered pondberry—and the DEIS claims will happen—the DEIS may not limit its analysis of impactsto plants tothis single species. See Section I of these comments for a discussion of the evaluations needed to assess impacts to the federally endangered pondberry.	The wetlands analysis evaluates both 1) the maintenance of plant communities and 2) provide fish and wildlife functions. The assessment made the assumption that all non-agricultural potential wetland areas in the 5-year flood were mature highly functional forested wetlands. This assumption accounts for any unanticipated shifts in vegetation composition. Plant community composition will be monitored over time, in addition to the referenced evaluations of federally listed plant species. The analysis was conducted using the assumptions that all areas subject to as little as one day of flood inundation are functioning as wetlands and that all non-agriculture lands experiencing flooding are highly functional mature forested wetlands. The extensive monitoring and adaptive management plan will include long-term monitoring of conditions within the study area to ensure that 1) impacts to wetlands were not underestimated, 2) any potential unanticipated impacts to wetlands can be quantified and addressed, and 3) the establishment of wetland mitigation successfully offsets impacts to wetlands resulting from project implementation. The monitoring will include an unprecedented array of shallow groundwater wells to quantify changes in wetland hydrology, along with repeated measurements of wetland functional capacity. The selected approach along with the considerations noted above promotes the responsible management of the valuable wetland resources in the Yazoo Backwater Area.
512	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	Wetlands	The DEIS Does Not Assess Impacts to Permanently Protected Wetlands The DEIS does not assess the impacts of the Yazoo Pumps Alternatives on the many acres of wetlands that are supposed to be permanently protected in the Yazoo Backwater Area. These include wetlands in: the Delta National Forest, multiple National Wildlife Refuges complexes, lands enrolled in the USDA Wetland Reserve Easement Program, mitigation lands for other federal civil works projects, and state-protected lands. It is essential to assess and document impacts to these vital, protected areas to understand the full scope of the damage that would be caused by the Yazoo Pumps Alternatives.	The assessment accounts for all potential wetland areas within the 5-year floodplain and will mitigate for all impacts to wetlands. The extensive monitoring and adaptive management plan will include long-term monitoring of conditions within the study area to ensure that 1) impacts to wetlands were not underestimated, 2) any potential unanticipated impacts to wetlands can be quantified and addressed, and 3) the establishment of wetland mitigation successfully offsets impacts to wetlands resulting from project implementation. The monitoring will include an unprecedented array of shallow groundwater wells to quantify changes in wetland hydrology, along with repeated measurements of wetland functional capacity. This will include study sites within DNF, WMAs, and other areas referenced in the comment.
513	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	Wetlands	The DEIS Does Not Assess Impacts to Wetlands from an Appropriate Range of Possible Operating Plans The DEIS does not assess impacts to wetlands under an appropriate range of possible operating plans. The DEIS does not provide a draft operating plan for the public to review, but what is clear from the DEIS is that even small changes in the operating regime can translate into significant additional wetland damage. For example, Alternative 2 includes 9 extra days of pumping below the 90-foot elevation as compared to Alternative 3. But these 9 extra days result in an additional 3,467 acres of wetland damage. The Corps added these 9 extra days of pumping in response to comments made during the scoping period public hearings. And the Corps is both considering—and is being asked to—make additional changes to the operating plan to operate the pumps for longer periods of time at and at lower elevations. See Section A of these comments. Even if the Corps does not adopt such changes now, operating plans can—and typically do—change over time. Indeed, the Corps' regulations require the Corps to "keep approved water control plans up to date" including by subjecting those plans "to continuing and progressive study by personnel in field offices of the Corps of Engineers."120 See Section A of these comments. In addition, the pressure to use the pumps more often and at lower elevations will undoubtedly intensify once the pumps are built. Given all of these factors, the proposed operating plans are not a reliable backstop for managing environmental harm (or for ensuring that the final selected plan is the least environmentally damaging practicable alternative). As a result, it is critical that the public and decision makers be made aware of the significant impacts that would accrue from the proposed 25,000 cfs pumping plant under a wide range of operating plans. Without this information it is not possible to assess the full array of potential risks associated with building the proposed, massive 25,000 cfs Yazoo Pumps. 120 33	If implemented, the project would operate according to the water management plan. Any significant changes to the operations plan would require concurrence from the EPA and USFWS.
514	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	Wetlands	The DEIS Does Not Assess Impacts to Streams The DEIS does not assess impacts to the rich array of rivers, streams, and bayous within the Yazoo Backwater Area.121 As discussed throughout these comments, the Yazoo Pumps Alternatives will adversely impact 89,839 to more than 93,306 acres of ecologically significant wetlands in the Yazoo Backwater Area. These wetland losses will affect the Yazoo Backwater Area streams. Intensifying agricultural production in the Yazoo Backwater Area, which is the fundamental purpose of the Yazoo Pumps (and when last assessed, accounted for more than 80% of project benefits) also will lead to through increased cultivation, additional fertilizer and pesticide use, and potential land clearing. These impacts also will unquestionably affect the Yazoo Backwater Area's streams. A state-of-the-art scientific review developed by EPA documents the hydrological connections and mechanisms by which streams and wetlands, singly or in aggregate, affect the physical, chemical, and biological integrity of downstream waters. The report, titled "Connectivity of Streams and Wetlands to Downstream Waters: A Review and Synthesis of the Scientific Evidence,"122 makes five major conclusions summarized below: (1) The scientific literature unequivocally demonstrates that streams, regardless of their size or frequency of flow, are connected to downstream waters and strongly influence their function. (2) The scientific literature clearly shows that wetlands and open waters in riparian areas (transitional areas between terrestrial and aquatic ecosystems) and floodplains are physically, chemically, and biologically integrated with rivers via functions that improve downstream water quality. These systems act as effective buffers to protect downstream waters from pollution and are essential components of river food webs. (3) There is ample evidence that many wetlands and open waters located outside of riparian areas and floodplains, even when lacking surface water connections, provide physical, chemical, and biological functions that could affect the integrity of downstream waters. Some potential benefits of these wetlands are due to their isolation rather than their connectivity. Evaluations of the connectivity and effects of individual wetlands or groups of wetlands are possible through case-by-case analysis. (4) Variations in the degree of connectivity are determined by the physical, chemical and biological environment, and by human activities. These variations support a range of stream and wetland functions that affect the integrity and sustainability of downstream waters. (5) The literature strongly supports the conclusion that the incremental contributions of individual streams and wetlands are cumulative across entire watersheds, and their effects on downstream waters should be evaluated within the context of other streams and wetlands in that watershed.Given these hydrological connections and mechanisms, the DSEIS must analyze and mitigate the impacts of the Yazoo Pumps Alternatives on the rivers, streams, and bayous in the Yazoo Backwater Area, including such things as: (1) changes in water temperature; (2) changes in flow; (3) changes to the form and function of stream and river channels, which are typically driven by changes in flow patterns, reductions in flow, reduction or loss of natural flood-pulse, and loss of overbank flooding; (4) changes to in-stream and floodplain habitats; (5) further reductions in groundwater resulting from loss of wetland functions and additional irrigation to support intensified agricultural production); and (6) changes to water quality, including increased sedimentation, nutrient pollution, toxic contamination, and lower levels of dissolved oxygen. See Section J of these comments for more information on required assessments of water quality impactsImpacts to stream resources must be separately evaluated and mitigated, as a matter of law. The DEIS cannot simply ignore the impacts to the project area's vast array of streams.	Impacts to streams were addressed in the Fisheries appendix. The monitoring and adaptive management plan includes water quality sampling and other measures to ensure unanticipated impacts to aquatic resources (including) wetlands are quantified and mitigated. A series of supplemental groundwater wells is under consideration to manage the stream network at the watershed scale, including the consideration of environmental flows.

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515	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	wetlands	1. Wetland Protection and Restoration Restoring and protecting wetlands is a highly practicable solution with a demonstrated record of reducing flood damages, as highlighted above. Restoring wetlands in the Yazoo Backwater Area to alleviate flooding instead of building the Yazoo Pumps would also: (i) avoid the many adverse impacts from the pumps, including diverting floodwaters onto other highly vulnerable communities; (ii) provide vital wildlife habitat for hundreds of fish and wildlife species and many millions of migratory birds and waterfowl; (ii) improve water quality, including by reducing nutrient runoff into the Yazoo and Mississippi Rivers; (iv) sequester carbon363; (v) make wildlife and communities more resilient to climate change; and (vi) reduce federal farm subsidy payments.364 Restoring and protecting wetlands in the Yazoo Backwater Area is clearly practicable as demonstrated by the acres in the Yazoo Backwater Area that already have been enrolled in the USDA Wetland Reserve Easement Program, which is one of the primary mechanisms for restoring and protecting wetlands (see Figure 5 below).As of FY2024 at least 59,786 acres of NRCS easements within the portions of these counties located within the Yazoo Backwater Area and applications have been filed for an additional 5027 acres of easements, according to information provided by the USDA Natural Resources Conservation Service:The practicability of protecting and restoring wetlands in the Yazoo Backwater Area is also demonstrated by the high demand for the Wetland Reserve Easement Program in Mississippi and throughout the Lower Mississippi Valley states. The Wetland Reserve Easement Program is oversubscribed in this region, which of course, means that many agricultural producers in the Yazoo Backwater Area want to take some of their marginal croplands out of production and restore thewetlands on those lands. Notably, there are no county or other caps limiting the acreage of marginal croplands with 4W+ soils that can be enrolled in Wetland Reserve Easements in the Yazoo Backwater Area. Data compiled by the NRCS shows that more than 1,000 separate Wetland Reserve Easement applications were pending in Arkansas, Louisiana, Kentucky, Mississippi, Missouri and Tennessee in FY2019. See Figure, below. But just 98 were funded that year, enrolling 18,534 acres at a cost of $71 million. This represents just 10% of lands that owners currently want to enroll and restore in the Lower Mississippi Valley states. Unfunded applications roll over from year to year, and efforts are underway to encourage Congress to increase funding to address the backlog in this program.The practicability of restoring and protecting wetlands in the Yazoo Backwater Area is also demonstrated by the fact that more than 250,000 acres in the Yazoo Backwater Area are already protected and managed as wetland resources for conservation and mitigation purposes. And critically, there is substantial interest in—and a significant need for—restoring forested and other wetlands in the Yazoo Backwater Area, as evidenced by the 2020 Lower Mississippi Valley Joint Venture Conservation Priorities in the Yazoo Backwater Area (see Figure, below).365 The U.S. Fish and Wildlife Service highlighted that Yazoo Backwater Area is the area with the "greatest potential" for meeting breeding bird habitat restoration and protection needs within the Mississippi Alluvial Valley in Fish and Wildlife Coordination Act Report prepared for the Yazoo Pumps 2007 SEIS.366Reforestation of the wettest lands in the Yazoo Backwater Area is a conservation priority, and there are no limitations (i.e., there are no county caps) on enrolling these lands in the Wetland Reserve Easement Program. Most of the 250,000 acres of conservation lands in the Yazoo Backwater Area have been established on the wettest soils. These wet soils, commonly known as 4W+ lands, are classified by USDA as "severely limited" for farming and are exempt from county caps on Wetland Reserve Easements. There are at least 46,000 acres of 4W+ lands in the Yazoo Backwater Area that are not in conservation, many of which are adjacent to existing conservation lands (see Figure below). Reforestation of remaining unprotected 4W+ lands is a conservation priority. Investments to increase Wetland Reserve Easement Program enrollments would greatly improve the financial security of farmers who plant crops on marginal lands.The practicability of wetland protection and restoration is also demonstrated by a $4.55 million project recently announced by the Mississippi Department of Environmental Quality. This project, "Migratory Bird Habitat Creation in the Lower Mississippi River Valley"367, will be funded through the National Fish and Wildlife Foundation's (NFWF) Gulf Environmental Benefit Fund as part of the state's recovery to the 2010 Deepwater Horizon oil disaster. The goal of this $4.55 million project is to create and enhance over 7,600 acres of migratory bird habitat in the Lower Mississippi River Valley to benefit waterfowl, shorebirds, and wading birds. This proposal focuses on public lands, namely state-managed Wildlife Management Areas and National Wildlife Refuges, which will serve to complement a similar NFWF-funded project from years ago that focused on private lands located in the same geography. The proposal will benefit public lands in seven counties, five of which are in the Yazoo Backwater Area, namely Humphreys, Issaquena, Sharkey, Warren, and Yazoo (see Figure below). This effort demonstrates there is widespread, sustained interest to directfurther investments in the habitat conservation, protection, and management of this critical ecoregion, particularly the Yazoo Backwater Area. The Yazoo Pumps only serve to undermine efforts like these.The practicability of wetland protection and restoration is further evidenced by the U.S. Fish and Wildlife Service's approval of the acquisition of 34,682 acres to expand the boundaries of National Wildlife Refuges in the Yazoo Backwater Area, including the approved 24,600 acres of acquisition approved for the Theodore Roosevelt National Wildlife Refuge Complex and Holt Collier National Wildlife Refuge.368	Due to the fact that wetlands within the indirect impact area are expected to experience shifts in wetland hydroperiod, but are unlikely to be converted from wetlands to uplands, implementation of the project in conjunction with establishment of mitigation areas (which accomplish restoration as described in the comment) will increase the overall extent of wetlands in the study area. While wetlands are effective at reducing flood risk, the lack of an outlet for floodwaters in the Backwater Area induces anthropogenically-induced prolonged flood inundation periods that can be damaging to natural resources. This effect was observed during the 2019 flood and during other floods in the study area.
516	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	wetlands	2. The DEIS Does Not Consider Highly Effective Natural and Nature-Based Measures The DEIS does not meaningfully consider highly effective natural and nature-based measures. These measures must be considered by the Corps as a matter of law. Such measures should be considered and selected because they are both demonstrably effective and cost-effective. Ample evidence demonstrates that nonstructural, natural and nature-based measures are both highly effective and cost-effective solutions for reducing flood and storm damages and that evidence continues to mount, as highlighted in the National Wildlife Federation's report on The Protective Value of Nature and in the examples provided below. As aptly noted by the Reinsurance Association of America: "One cannot overstate the value of preserving our natural systems for the protection of people and property from catastrophic events." The value of wetlands for reducing flood risks has long been recognized by the Corps, including in a 1972 study evaluating options to reduce flooding along Charles River in Massachusetts where the Corps concluded: Nature has already provided the least-cost solution to future flooding in the form of extensive [riverine] wetlands which moderate extreme highs and lows in streamflow. Rather than attempt to improve on this natural protection mechanism, it is both prudent and economical to leave the hydrologic regime established over millennia undisturbed. A single acre of wetland can store 1.5 million gallons of floodwaters. Just a 1 percent loss of a watershed's wetlands can increase total flood volume by almost seven percent.387 Wetlands prevented $625 million in flood damages in the 12 coastal states affected by Hurricane Sandy, and reduced damages by 20 to 30 percent in the four states with the greatest wetland coverage. Coastal wetlands reduced storm surge in some New Orleans neighborhoods by two to three feet during Hurricane Katrina, and levees with wetland buffers had a much greater chance of surviving Katrina's fury than levees without wetland buffers. As an example, wetlands prevented $625 million in flood damages in the 12 coastal states affected by Hurricane Sandy, and reduced damages by 20 to 30 percent in the four states with the greatest wetland coverage. The forest and other conservation lands that make up the 28,000 acre Meramec Greenway along the Meramec River in southern Missouri contribute about $6,000 per acre in avoided flood damages annually. Wetlands in the Eagle Creek watershed of central Indiana reduce peak flows from rainfall by up to 42 percent, flood area by 55 percent, and maximum stream velocities by 15 percent. Coastal wetlands reduced storm surge in some New Orleans neighborhoods by two to three feet during Hurricane Katrina, and levees with wetland buffers had a much greater chance of surviving Katrina's fury than levees without wetland buffers. Natural and nature-based solutions are also often more cost-effective than structural measures. A recent study documents that using natural and nature-based solutions for reducing coastal flood risks in Texas, Louisiana, Mississippi, and Florida would have a benefit-cost ratio of 3.5 compared to just 0.26 for levees and dikes. Restoring wetlands in this region could prevent $18.2 billion in losses while costing just $2 billion to carry out.	Natural and nature-based solutions do have the potential to yield benefits (including flood risk), and were considered during the study as evidenced by the proposal to re-establish e-flows within the basin through construction of supplemental groundwater wells to support fisheries. However, the lack of a mechanism to remove water from the system via natural drainage or other means limits the capacity of NBS to address flooding in the study area.

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517	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	wetlands	Natural infrastructure also has the significant added benefits of being self-sustaining and avoiding the risk of catastrophic structural failures. Importantly, natural infrastructure can work both alone and in combination with more traditional grey infrastructure to reduce flood and storm risks. Non-structural, natural and nature-based solutions are being used by communities across the country to reduce flood risks. For example: • In California, the Napa Valley Flood Control Project is using a community-developed "living river" plan to reduce flood damages along the flood-prone Napa River. This plan replaces the Corps' originally-proposed floodwalls and levees with terraced marshes, wider wetland barriers, and restored riparian zones. The Project will restore more than 650 acres of high-value tidal wetlands of the San Francisco Bay Estuary while protecting 2,700 homes, 350 businesses, and over 50 public properties from 100-year flood levels, saving $26 million annually in flood damage costs.395 Though only partially complete, the project was credited for lowering flood levels by about 2 to 3 feet during the 2006 New Year's Day flood. • In Florida, the Corps is using wetland restoration in the Upper St. John's River floodplain to provide important flood damage reduction benefits. The backbone of this project is restoration of 200,000 acres of floodplain which will hold more than 500,000 acre-feet of water—enough to cover 86 square miles with 10 feet of water—and will accommodate surface water runoff from a more than 2,000 square mile area. The Corps predicts that this $200 million project will reduce flood damages by $215 million during a 100-year flood event, and provide average annual benefits of $14 million. This project was authorized by Congress in 1986 to reduce flood damages along the river. • In Illinois, wetlands in the seven-county Chicago metropolitan area provide an average $22,000 of benefits per acre each year in water flow regulation, as documented by a 2014 study conducted for the Chicago Wilderness Green Infrastructure Vision. This study also found that watersheds with 30 percent wetland or lake areas saw flood peaks that were 60 to 80 percent lower than watersheds without such coverage, and that preventing building in floodplain areas could save an average of $900 per acre per year in flood damages. • In Iowa, the purchase of 12,000 acres in easements along the 45-mile Iowa River corridor saved local communities an estimated $7.6 million in flood damages as of 2009. The easement purchase effort began after the historic 1993 floods when river communities in east-central Iowa recognized the need for a more effective approach to reducing flood damages. • In Massachusetts, the Corps recommended preserving 8,000 acres of floodplain wetlands along the Charles River after finding that upstream wetlands were playing a critical role in reducing flooding in the middle and upper reaches of the Charles River by storing millions of gallons of water and preventing $17 million each year in flood damages. This approach was sanctioned by Congress in 1974 when it authorized the Charles River Natural Valley Storage Area. Preserving these wetlands cost just one-tenth of the structural project the Corps had previously planned to build. These floodplain wetlands are credited with reducing major floods, including in 1979, 1982, and 2006. The Corps estimates that this project has prevented $11.9 million in flood damages while providing recreational benefits valued at between $3.2 and $4.6 million. • In New York, restoration of wetlands and lands adjacent to 19 stream corridors in Staten Island "successfully removed the scourge of regular flooding from southeastern Staten Island, while saving the City $300 million in costs of constructing storm water sewers." Some acres of freshwater wetland and riparian stream habitat has been restored along 11 miles of stream corridors that collectively drain about one third of Staten Island's land area. A 2018 study commissioned by the City of New York found that using "hybrid infrastructure" that combines nature, nature-based, and gray infrastructure together could save Howard Beach, Queens $225 million in damages in a 100-year storm while also generating important ecosystem services. • In Oregon, the Portland Bureau of Environmental Services restored 63 acres of wetland and floodplain habitat, restored 15 miles of Johnson Creek, and move structures out of high risk areas to reduce flood damages in the Johnson Creek neighborhood. In January 2012, when heavy rainfall caused Johnson Creek to rise two feet above its historic flood stage, the restored site held the floodwaters, keeping nearby homes dry and local businesses open. An ecosystem services valuation of the restored area found that the project would provide $30 million in benefits (in 2004 dollars) over 100 years through avoided property and utility damages, avoided traffic delays, improved water and air quality, increased recreational opportunities, and healthy fish and wildlife habitat. • In Texas, restoration of a 178-acre urban wetland—formerly an abandoned golf course—acted as a sponge to store 100 million gallons of water during Hurricane Harvey, protecting 150 homes in Houston's Clear Lake community from serious flooding. This project will store up to a half billion gallons of water and protect up to 3,000 homes when it is completed in 2021. • In Vermont, a vast network of floodplains and wetlands, including those protected by 23 conservation easements protecting 2,148 acres of wetland along Otter Creek, saved Middlebury $1.8 million in flood damages during Tropical Storm Irene, and between $126,000 and $450,000 during each of 10 other flood events. Just 30 miles upstream, in an area without such floodplain and wetland protections, Tropical Storm Irene caused extensive flooding to the city of Rutland. To assist the Corps in assessing and implementing these types of solutions in the Yazoo Backwater Area, the Conservation Organizations have repeatedly provided the Corps with a proposal for a detailed Resilience Alternative and important information to help guide on-the-ground implementation of the measures included in that Resilience Alternative. The Resilience Alternative is discussed in Section M of these comments.	The examples referenced in the comment yield benefits by decreasing flood energy and storing water flowing towards an outlet. Unfortunately, the current configuration of the Yazoo Backwater lacks a mechanism to remove water from the system during high stages on the Mississippi River. As a result, the referenced NBSs have limited capacity to reduce flooding in the basin. However, establishment of a mechanism to remove water from the lower portion of the system (i.e., an outlet) via pumping or another approach would provide for opportunities to established NBS in portions of the study area. Additionally, many of the referenced examples occur on souls with high infiltration rates and high organic matter contents, both characteristics lacking within the Backwater.
518	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	Wildlife	Notably, as discussed throughout these comments, the adverse impacts to the hundreds of species of fish and wildlife that rely on the Yazoo Backwater Area wetlands will be much greater than acknowledged in the DEIS. Indeed, the DEIS fails to assess an extensive array of impacts to those species.	See response to comments 1, 45, 67, 90, 113, and 503
519	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	wildlife	The 404(b)(1) Guidelines prohibit a discharge that jeopardizes the continued existence of species listed as endangered or threatened under the Endangered Species Act.70 As of 2020, there were 62 distinct pondberry colonies in the Yazoo Backwater Area, including 50 on the Delta National Forest and 12 on private lands in Bolivar and Sunflower counties. As discussed in Section I of these comments, the Corps has not finalized the required formal consultation on the pondberry or the other listed species in the Yazoo Backwater Area. The Yazoo Pumps Alternatives will be prohibited by the 404(b)(1) Guidelines it the pumps would jeopardize the continued existence of the pondberry or other listed species.	1.The number of colonies noted in this comment is incorrect and significantly understated, based on work completed during 2020-2023 by the U.S. Army ERDC Environmental Laboratory. Significant updates are provided in the Corp's Biological Assessment (2024) provided to the USFWS in July 2024. 2.After revisiting all known historic pondberry locations within the Yazoo Backwater Area from 2020-2023, along with discovery surveys that found additional colonies, there are 122 known extant pondberry populations in the Delta National Forest within the project area, only one of which occurs below 90.0 ft (and this colony's stem count was greatly reduced after the 2019-2020 floods compared with pre-2019 counts), and 22 colonies at or below 93.0 ft. Sixty extant colonies on private land were also surveyed, including 55 colonies at the Hester Tract north of the Yazoo Backwater Area and at higher elevation, where stem counts and plant sizes were significantly larger than those at lower elevations in the Yazoo Backwater that experience occasional deep and long-duration flooding such as experienced in 2019 and 2020. Consultation was initiated in July 2024 with USFWS through transmission of a BA. The USFWS has 135 days to respond with its BO. 3.In our BA, we noted that the YBW Pumps project would be Likely to Adversely Affect (LAA) colonies in the 90-93' NGVD zone, and Not Likely to Adversely Affect (NLAA) those colonies above elevation 93' NGVD. We provide significant discussion and rationale for these determinations, and note other threats and stressors (e.g., palmetto invasion, wild hogs) as being of more concern for continued existence of pondberry in the Yazoo Backwater, than the proposed water management plan.

Comment Number	Comment Date	Org.	Theme	Comment	Response
520	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	wildlife	F. The DEIS Significantly Understates Impacts to Native Birds The DEIS significantly understates the adverse impacts of the Yazoo Pumps Alternatives on the rich array of bird species that rely on the Yazoo Backwater Area (and as a result, the mitigation that would be required to attempt to offset those impacts). For example, the DEIS fails to assess impacts on native bird species during critical life-cycle periods—which unquestionably results in the DEIS significantly understating impacts. The limited assessments that have been carried out are plagued by substantially flawed assumptions and a fundamental lack of transparency that render these models questionable at best, and incorrect at worst. The failure to assess the full array of impacts to native birds is an egregious error, given the hemispheric significance of the Yazoo Backwater Area to bird species. As discussed above, the Yazoo Backwater Area's hemispherically significant wetlands are located in the heart of the Mississippi River Flyway—a major continental migration corridor—and support 257 bird species, including several species recognized as state and/or federally threatened or endangered, or as a Species of Greatest Conservation Need.131,132 Approximately 60% of all North American bird species depend upon the Mississippi River basin's habitats, including 40% of all waterfowl and shorebirds that migrate along the Mississippi River Flyway.The value of the Yazoo Backwater Area is further demonstrated by the myriad of state and/or federally managed refuge, forest, and wildlife management areas located in the Yazoo Backwater Area that have been recognized as by BirdLife International and the National Audubon Society as Important Bird Areas (IBAs) for resident and migratory birds and waterfowl. These include Delta National Forest, Panther Swamp and Yazoo National Wildlife Refuges, and Mahannah Wildlife Management Area, as well as Eagle Lake in Warren County.133 In addition, the Lower Mississippi Valley Joint Venture has identified additional wetland areas within the Yazoo Backwater Area that should be protected and restored to sustain bird populations.134,135 For the most abundant 180 species that rely on the Yazoo Backwater Area, approximately 29 million birds use the region, as documented by an eBird abundance analysis prepared by the National Audubon Society136: • More than 18 million birds migrate through the Yazoo Backwater Area each year during fall migration, including approximately 6.6 million shorebirds.137 • More than 10 million birds migrate through the Yazoo Backwater Area each year during spring migration, including 2.8 million shorebirds.138Audubon estimates that the Yazoo Backwater Area supports more than 10% of the continental population for 12 species of birds during either spring or fall migration (Figure 1). Five of those species are projected to lose more than 50% of their populations in the next 50 years without significant conservation action, referred to as "tipping point" species. One additional tipping point species, the Short-billed Dowitcher, also relies heavily on the Yazoo Backwater Area which is used by approximately 8% of the Short-billed Dowitcher's hemispheric population in fall migration. Six of these species have been identified by the 2022 Partners in Flight State of the Birds report143 as "on alert" species, defined as species that have lost at least 50% of their populations from 1970-2019. Each of these species has slightly different water requirements, such that variation in the amount (i.e., depth) and seasonal timing of water in the landscape is necessary to maintain existing population levels for all of these species. For example, long-legged wading birds (e.g., Snowy Egret and Roseate Spoonbill) prefer shallow standing water, often < 15 cm in depth144,145, whereas small sandpipers prefer a thin sheet of water (i.e., < 4 cm in depth) or exposed mudflats146,147, and waterfowl prefer deeper waters, such as around 30 cm for Blue-winged Teal148,149. The timing of these water needs also differs among taxa, especially in fall and winter, with long-legged wading birds dispersing into the region from large rookeries to the south between late June through August, migratory shorebirds between mid-July through October, and some waterfowl from as early as August (i.e., Blue-winged Teal), but primarily from October through March. These species have evolved the timing of their migrations to best match the natural climatic and hydrological processes in the Mississippi River watershed. Bird migration requires a series of links of key regions and habitats, connecting the arctic in northern Canada to the southern tip of Argentina. Should any of these links be broken for the species that depend on them, the entire migration balance falls apart. Human modifications to those vital links have resulted in the loss of 2.5 billion migratory birds from the U.S. and Canada in just the last 50 years.150 Alternatives 2 and 3 will amplify this dire problem, with negative population-level consequences for multiple species. It is beyond dispute that the Yazoo Pumps would cause unacceptable harm to native birds, as unequivocally recognized in the 2008 Clean Water Act veto. For example • More than 6.3 million birds from 17 different species overwinter in the Yazoo Backwater Area during the overwintering period from December through February.139 Each of these 180 species of birds also utilize (migrate and/or breed) in the region during the Alternative 2 and Alternative 3 crop seasons, when the 25,000 cfs pumps will drain water below the 2-year floodplain elevation (90-feet NGVD). As a result, the proposed Yazoo Pumps Alternatives will drain water to exceptionally low levels—levels explicitly prohibited by the 2008 Clean Water Act veto—precisely when that water is needed the most by migratory and breeding birds. Water levels will also be kept at artificially low levels when the water is needed the most by overwintering birdsThe loss of the productive shallowly flooded wetlands, especially in the spring months when the proposed pumps will typically be in operation, will impact migratory birds such as shorebirds and waterfowl as they stopover and forage in preparation for their seasonal migration. Fewer shallowly flooded wetlands will reduce foraging habitat, which will equate to reduced nutritional uptake and could result in higher mortality or reduced reproductive fitness as the birds travel the great distances between their southern wintering areas and their breeding areas in the northern U.S., Canada, and the Arctic. Breeding for many species could be adversely affected during the spring-time nesting season because foraging areas would be reduced. As a result of the reduction in flooding, adult birds will have to travel longer distances to find food, which equates to longer times away from the nest or foraging for food and may ultimately lead to higher nest mortality and lower recruitment (Appendix 4).151 . . . The proposed project would reduce the extent of flooding within wetlands in the 2- to 5-year floodplain potentially from January through June. The reductions to late winter and spring flooding would result in significant adverse impacts to those birds which not only utilize the Yazoo Basin, but are dependent upon backwater flooding during these periods…The reduction in the extent and duration of the spring flood pulse would accelerate the decline of many bird species that depend upon the wetland habitats of the lower Yazoo River (Appendix 4).152 . . . For many shorebird species, migration "stop-over" habitats play a vital role in their ability to accumulate fat reserves. Shorebirds unsuccessful in obtaining necessary fat are thought to have very low survival rates (Brown, Hickey, and Harrington, 2000). If these fat deposits are crucial for breeding and if they are dependent on feeding conditions on migratory stopovers south of breeding area, then changes in quantity and quality of migratoryhabitat could influence breeding populations and fitness parameters (Appendix 4).153 The Clean Water Act veto also makes clear that the project-induced damage to wetland plants will compound the adverse impacts to native birds from the loss of habitat. For example: Different wetland species require wet and dry conditions at different times in their life cycle. The various elevations of land in a floodplain combined with various hydrologic events create numerous habitat conditions which are available to animals and plants at different times. It was the spatial and temporal heterogeneity of these bottomland hardwood ecosystems which provided the components for the great biodiversity for which this region was once known (Schnitzler et al., 2005), vestiges of which remain today. The topographic and hydrologic complexity of floodplains is important to the distribution of plant communities, and it is these plant communities that create the primary production necessary to support the immensely diverse food web that make bottomland hardwood ecosystems unique Floristic composition and successional patterns are strongly influenced by the hydrologic events on the sites and particularly by rates and types of deposition. Small differences in elevation can result in great differences in site quality primarily because of differences in hydrology (Hodges, 1997).155 . . . The ability of riverine backwater wetlands to maintain a characteristic plant community is important because of the intrinsic value of the plant community and the many attributes and processes of wetlands that are influenced by the plant community. For example, primary productivity, nutrient cycling, and the ability to provide a variety of habitats necessary to maintain local and regional diversity of animals are directly influenced by the plant community. Due to the inundation by nutrient rich surface water, diverse assemblages of plants grow in riverine backwater wetlands and contribute to the primary production of these ecosystems. The growth of different plant communities as a result of variable hydrologic regimes and topography contributes to the uptake and release of nutrients and provides many layers of potential habitat (i.e., litter layer to canopy) for the hundreds of wildlife species which utilize these wetlands. In addition, the plant community of river connected wetlands such as riverine backwater wetlands in the Yazoo River Basin influences the quality of the physical habitat, nutrient status, and biological diversity of downstream systems. As noted in the Yazoo Basin HGM Guidebook, maintaining the natural hydrologic regime of these wetlands is consistently cited as the principal factor controlling plant community attributes (Smith and Klimas 2002).156Most wildlife and fish species found in riverine backwater wetlands of the Yazoo River Basin depend on certain aspects of wetland structure and dynamics such as specific vegetation composition and proximity to other habitats, but of particular importance to the life cycles of these species is the periodic flooding or ponding of water associated with the hydrologic regime of riverine backwater wetlands (Smith and Klimas 2002).157 . . . In addition to the information provided in the FSEIS, EPA evaluated additional information regarding faunal assemblages and species in the project area, including information provided by the FWS at the request of EPA (Appendix 4). As noted above, the Yazoo Backwater Area is an area that is micro-topographically and geomorphologically diverse. It can be broadly classified as a river-floodplain ecosystem characterized by seasonal floods which exchange nutrients and organisms among a mosaic of habitat types. The movement of surface water onto the floodplain and the associated exchange of materials lead to the biological productivity of these bottomland hardwood ecosystems (Junk et al., 1989; Bunn and Arthington, 2002; and Sparks, 1995). A growing body of evidence indicates that the ecological diversity and integrity of large floodplain rivers are maintained by flood pulses, channel-forming floods, and by river-floodplain connectivity. The native biota has developed strategies to take advantage of these flood pulses.158 The Clean Water Act veto also makes clear that the project-induced impacts to amphibians and reptiles will compound the adverse impacts to native bird species. For example: All of the 21 amphibian species, and all but 5 of the 37 reptile species benefit from the flood pulse. Shallow areas at the periphery of the flooded zone hold water for the shortest period, from days to a couple of months, and provide breeding habitat for species such as the mole salamanders, which are winter breeders in Mississippi, and for winter-breeding frogs such as leopard frogs, pickerel frogs, spring peepers, and chorus frogs. Areas which are deeper and flooded for longer periods (i.e., places closer to the main channel of the river) are utilized by the summer-breeding frog species as water levels drop in late spring and summer. Larval amphibians make significant contributions to the biomass of other vertebrates, including many of the wading birds. Aquatic turtles, such as the common red-ear slider, also support the diet of many species of fish, birds, and mammals, which eat their eggs and hatchling turtles. Turtles produce several clutches of eggs per season, over a reproductive lifetime of several decades, and thus can be a significant food source for numerous aquatic and terrestrial species (Appendix 4).159Fourteen of 18 species of wading birds found in North America use bottomland hardwood habitats, and 12 of these species breed regularly in this system (Heitmeyer et al., 2005). Diets of most wading birds vary with seasonal availability, and many species forage extensively on small fish, amphibians, reptiles, and crayfish. Waders generally depend on seasonally-fluctuating water levels in bottomland hardwood and associated wetlands to make prey more available. One species that nests in the Yazoo Backwater Area, the Little Blue Heron, has recently shown declines in its population. Although the overall causes for this population change cannot be directly determined, it is believed that altered hydrocycles and habitat conversion have caused and continue to cause the greatest threats to this species. Food limitation, caused by wetland destruction and degradation, appears to be a significant factor controlling its breeding success and, therefore, its population numbers (Rodgers and Smith, 1995). Among the wading birds listed as priority species for management in the LMRAV are the following: Little Blue Heron, Tricolored Heron, American Bittern, Least Bittern, Black-crowned Night Heron, Yellow-crowned Night Heron, Great Egret, White Ibis, and Wood Stork (Appendix 4).160 As discussed below, the DEIS significantly understates the impacts of Alternatives 2 and 3 on the native birds that rely on the Yazoo Backwater Area and, as a result the mitigation that would be required to attempt to offset those impacts. 158 2008 . . .	The species that were analyzed for the YBA DEIS were all agreed upon within the interagency team (USACE, USFWS, and EPA). The Corps provided a list of species and models to the interagency team for concurrence and the interagency team agreed upon these species for the YBA EIS so that multiple taxonomic groups would be included (e.g. waterfowl, shorebirds, wading birds) to ensure impacts to the overall ecosystem were mitigated for any impacts. While these assessments often focused on specific groups or species, the intent was that through these various assessments that impacts to the overall ecosystem would be accounted for rather than focusing on any one species or group. The Corps is also limited by certified models for determining impacts and subsequent mitigation which was a consideration by the interagency team making the selection. The Engineering Appendix outlines how the operation of the pump would have occurred throughout the period-of-record. It is important to note that the pump would have barely operated during the fall or winter periods as water levels generally do not reach necessary elevations to allow for its operation. Therefore, the primary impacts would occur during the spring and to a lesser extent, early summer. Comments related to specific taxonomic groups such as Waterfowl or Shorebirds further address these concerns below within their designated sections. It is also important to note the frequency for which the pumps would have operated (again, see Engineering Appendix). There are many years in which the pump would have either not operated at all (23/43 years between 1978 and 2020, and each year since 2020), or not operated during specific time periods for which species would have been impacted (e.g., pumps would not have operated at all during fall migration since the 1978 start of the period of record). The proposed mitigation for shorebirds would be managed every year during spring and fall migration resulting in an increase of habitat which is particularly important during dry years when the pump would not operate. In years in which the pump would be utilized, the larger landscape would still provide significant habitat for migratory birds, including shorebirds, and those periods would inherently be wetter across the landscape during which time above-average localized precipitation is more likely to inundate depressional areas. Migratory "stepping stones" are critical along the migration pathway; however, these stepping stones must also be reliable from year to year. The YBA often goes several years without the need for operation of the pump (as defined in alternative 2 and 3) during these critical times during migration. Water levels below 90 feet elevation will not be impacted, such that significant habitat that is influenced by more frequent backwater flooding will remain reliable, particularly for species inhabiting forested environments. This is not to say that impacts to the YBA will not occur to some level (see wildlife sub appendices), but species heavily utilize this area based on current conditions and water levels even during years and periods when the proposed pump would not have operated. It is important to distinguish "wetlands" from breeding bird habitat. Surface inundation is not a criterion for a wetland; therefore, impacted acres within other appendices (e.g. Wetland Appendix) should not be compared against other appendices related to migratory bird habitat. Analyses that incorporate a suitability index (e.g. habitat suitability index or functional capacity index) consider any unit (e.g. raster cell, acres within a polygon) with a difference in score as being "impacted"; however, the difference in scores between alternatives could result in minimal mitigation. For example, a 100-acre parcel with a suitability score difference of only 0.03 would still be reported as 100-acres impacted but would also result in few mitigation acres for that 100-acre parcel. In other words, it represents a loss of function to a varying degree rather than a total loss of habitat.

Comment Number	Comment Date	Org.	Theme	Comment	Response
521	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	wildlife	4. The DEIS Significantly Understates Impacts to Secretive Marsh Birds (Appendix F-4, E) The DEIS analysis of impacts to secretive marsh birds200 is fundamentally flawed and cannot be relied upon. Multiple problems with the DEIS wading bird analysis are highlighted below. First, the DEIS marsh bird model identifies habitat types that do not provide marsh bird habitat as providing suitable habitat for marsh birds. For example, the model includes "Eastern Warm Temperate Developed Herbaceous and "Eastern Warm Temperate Urban Herbaceous"201 (as defined in the Landfire(2022) and Cropscape (2023) databases202) as providing marsh bird habitat. However, the Landfire database defines these habitat types as "Urban/Developed Grassland" which is not marsh bird habitat. Second, the DEIS marsh bird model (like the shorebird model) relies on lands with a seasonal average of 0.0 feet of flooding as marsh bird habitat. This is fundamentally inappropriate because areas with 0.0 feet of flooding are dry land and thus, unsuitable for marsh birds. Third, the DEIS marsh bird model includes a range of 0 to 18 inches of flooding as providing suitable habitat. Relying on this range further dilutes the model's ability to detect the specific needs of individual marsh bird species, such as between King Rails and Common Gallinules, which live on different ends of the wetland water depth spectrum. This reliance prevents the model from being able to detect whether the needs of specific species or a marsh bird community structure would be impacted by the Yazoo Pumps Alternatives. Fourth, the DEIS fails to provide an accurate assessment of the amount of marsh bird habitat in the Yazoo Backwater Area. For example, the DEIS lumps together more than 10% of habitat as "other" which the DEIS defines as being "comprised of lands around the edges of other land cover types, cloud cover, undefined, and scrublands."203 This "other" habitat could include a significant amount of marsh bird habitat—and likely far more than the total marsh bird habitat identified in the DEIS. There are approximately 7,000 acres of "other" habitat types between the 90- and 93-foot elevation and approximately 16,000 acres of "other" habitat types the 93- and 98.2-foot elevations. Despite this extensive acreage of possible marsh bird habitat, DEIS Table 3-3 identifies just 164 acres of marsh bird wetland habitat between 90 and 93 feet, and just 93 acres between 93 and 98.2 feet. Fifth, the DEIS has appears not to have relied on accurate assessments of secretive marsh populations in the Yazoo Backwater Area, which would skew the assessment of impacts. For example: • The DEIS marsh bird analysis appears to be relying at least in part on IPaC to determine population levels in the Yazoo Backwater Area.204 However, IPaC must be used with caution as it does not provide a definitive tool for determining the presence/absence of species. Instead, IPaC is based on the expected range of each species (to serve its primary purpose of encouraging consultation with the U.S. Fish and Wildlife Service). Specifically, IPaC states: "The primary information used to generate this list is the known or expected range of each species. Additional areas of influence (AOI) for species are also considered. An AOI includes areas outside of the species range if the species could be indirectly affected by activities in that area (e.g., placing a dam upstream of a fish population even if that fish does not occur at the dam site, may indirectly impact the species by reducing or eliminating water flow downstream). Because species can move, and site conditions can change, the species on this list are not guaranteed to be found on or near the project area. To fully determine any potential effects to species, additional site-specific and project-specific information is often required. • Although the DEIS recognizes the importance for conducting standardized marsh bird surveys, the secretive marsh bird appendix relies merely on species-specific summaries of eBird data, which clearly do not approach the rigor of standardized marsh bird surveys. Further, the raw eBird numbers provided in the DEIS do not match the information in the eBird public-facing database. eBird includes both "confirmed" and "unconfirmed" records. Unconfirmed records are not available in the public-facing maps and bar charts but are available from the database. Analyses that utilize eBird data should specify what was retrieved (spatial and temporal bounds) and when the data was retrieved (as historic records can always be added later). This is perhaps of little consequence, however, because importantly, a more appropriate way to use eBird for assessing the status of marsh birds in the region would be by reviewing their peer-reviewed Science portal and examine eBird predictive distribution maps rather than using raw eBird outputs. This is particularly important for the DEIS marsh bird analysis because the region is under-birded and secretive marsh birds are notoriously difficult to detect, as the DEIS acknowledges. • The DEIS also provides incorrect information on the methods that could be used to carry out standardized marsh bird surveys, which is important for understanding the Corps could have in fact carried out such surveys to improve its analysis. The DEIS does not rely on (and presumably the Corps did not carry out) surveys to assess marsh bird population numbers, stating instead that "Typical avian sampling methods such as point count or transect surveys are unlikely to result in detection of these species. However, most secretive marsh birds, particularly rails, often respond to play-back recordings."206 This is an oversimplified statement, and all species of marsh birds can absolutely be detected without the use of playback, especially during the peak of breeding early in the morning or late in the evening. The use of playback in standardized marsh bird surveys is instead recommended to improve detection rates, thus making the detection-per-unit-effort of playback-based surveys more efficient and effective, and improving a researcher's ability to generate occupancy or density estimates.207 The DEIS should use language that correctly disseminates how and why such datasets might be collected in order to help the public understand limitations in the evaluation of the project Alternatives on marsh birds as presented in the DEIS, given that no standardized marsh bird datasets currently exist for the Yazoo Backwater Area. The DEIS list of eight species of secretive marsh birds expected in the region is incorrect. Clapper Rail should be removed from consideration, and Least Bittern, American Bittern, Pied-billed Grebe, and American Coot should be added, resulting in a list of 11 species. See USFWS National Protocol Framework for the Inventory and Monitoring of Secretive Marsh Birds Sixth, the DEIS secretive marsh bird analysis lacks transparency, making it difficult to ass the full range of the potential problems with the model, and the secretive marsh bird write-up is confusing. Seventh, the DEIS does not assess or account for the impacts to secretive marsh birds in light of the full suite of direct, indirect, and cumulative impacts that will adversely affect secretive marsh birds that rely on the Yazoo Backwater Area. The DEIS may not properly rely solely on outputs from a secretive marsh bird model to assess marsh bird impacts, even if the DEIS used an appropriate model populated with accurate information. As a result of these many failings, the DEIS significantly understates secretive marsh bird impacts.	We took the most conservative approach for delineating land cover types that may be suitable for marsh birds. If there are any extraneous land cover types in the model, this only serves to increase the estimate of pumping effects to marsh birds. Thus, removing any extraneous land cover types would result in less significant effects (i.e. less mitigation acreage). Our model did not include water depths of zero, instead areas that were flooded up to either 8.4 inches (preferred depth) or up to 18 inches so as to provide the most conservative approach of including areas that are considered to be impacted, but in reality are likely not used by marsh birds such as King Rail due to water depth too deep. Again, this takes the more conservative approach in over-estimating areas that may not be used by all species but results in the highest impact being considered. Our model did not include water depths of zero, instead areas that were flooded up to either 8.4 inches (preferred depth) or up to 18 inches so as to provide the most conservative approach of including areas that are considered to be impacted, but in reality are likely not used by marsh birds such as King Rail due to water depth too deep. Again, this takes the more conservative approach in over-estimating areas that may not be used by all species but results in the highest impact being considered. Our definition of emergent wetland is a liberal approach that maximizes what may be considered marsh bird habitat in the YBA. By using the broadest definition of marsh bird habitat, we maximized the potential effects of the pumping alternatives. Given the scale and timeline of this analysis, we could only rely on remotely sensed datasets to identify pertinent habitat. Any areas that are classified as "other" are much more likely to be non-marsh bird habitat as marsh bird habitat given the relative lack of emergent wetland in the YBA, which was noted during our field work for other taxa throughout the YBA. Regardless, we had to rely on the remotely sensed dataset and could not divine beyond the scope of what existed in the dataset. Marsh vegetation must rely on frequent inundation which likely coincides with elevations at or below the one-year flood frequencies. Areas outside of elevation 90 (2-year flood frequency) do not achieve the frequent inundation events to sustain long-term conditions to support marsh habitat. Therefore, operation of the pump is likely to have little to no impact on these habitats and thus species that inhabit these areas as the remotely sensed spatial analysis suggest. Many of the marsh areas that do support species such as King Rail occur on protected lands (e.g. Yazoo National Wildlife Refuge) with water control structures that manage these sites without any impact from operation of the proposed pump. Predictions of abundance from eBird models are not necessarily any more useful than using individual ebird records. These abundance layers are simply predictions and may not hold up to ground truthing, especially in underrepresented areas in which there is sparse eBird data for uncommonly detected species. That being said, estimates of marshbird species richness and abundance simply served to provide context and background information to the analysis. No part of the secretive marsh bird effects analysis relies on accurately determining occurrence and abundance of specific species throughout the backwater area. Our analysis inspects loss/gain of typical marsh bird habitat, regardless of bird abundance. Estimates of marshbird species richness and abundance simply served to provide context and background information to the analysis. No part of the secretive marsh bird effects analysis relies on accurately determining occurrence and abundance of specific species throughout the backwater area. Our analysis inspects loss of typical marsh bird habitat, regardless of bird abundance. That being said, most secretive marsh birds, especially rails and bitterns, are sparse within the backwater area, and no data source available refutes that. Although relatively simplistic, the methods in the marsh bird section are very straightforward. We simply identified the intersection between suitable land cover types and suitable water depths to delineate marsh bird habitat. We then compared the amount of suitable habitat among the alternatives. We agree that assessing the full suite of direct, indirect, and cumulative impacts on secretive marsh birds would be very difficult via outputs from a secretive marsh bird model. This is why we chose to simply compare amounts of all broadly defined potential habitat under base and proposed pumping alternatives.

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522	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	wildlife	5. The DEIS Significantly Understates Impacts to Migratory Landbirds (Appendix F-4, A) The DEIS significantly understates impacts to migratory landbird species209, including because it does not assess impacts during migratory and over-wintering periods. Numerous problems with the migratory landbird analysis are highlighted below. First, the migratory landbird analysis does not assess impacts during the migration and over-wintering periods. The DEIS only looks at potential landbird impacts during the period from March 15 through July 31.210 Among other things, this means that the DEIS: has not assessed impacts to the Rusty Blackbird, which is one of the fastest declining birds in North America (about 90% since the 1960s) and is extremely sensitive to drying and flooding during the non-breeding season; and has not assessed impacts to the Golden-winged Warbler, which is a candidate species under the Endangered Species Act that migrates through the region in spring and fall. Second, the results of the migratory landbird assessment appear to be inconsistent with the conclusions in the DEIS that the Yazoo Pumps Alternatives would affect 89,839 to 93,306 acres of wetlands, depending on the final alternative selected. Despite these extensive wetland impacts, most of which will occur in bottomland hardwood wetlands, the landbird assessment suggests that there will only be minimal impacts to forested wetland dependent landbirds like the Prothonotary Warbler (PROW) and Acadian Flycatcher. A more in-depth presentation of the analysis, especially its hydrological inputs and assumptions, is needed to understand this and other rather apparent and substantial inconsistencies. For example, as acknowledged in the DEIS: "The PROW is a cavity-nesting species dependent on forested wetland habitats (Petit 2020). This species is common to abundant in forested areas along the Mississippi River and in the YBA along forested rivers, creeks, oxbows, sloughs, and other depressional wetlands, especially those that hold water during the breeding season. Because of their dependence on these floodplain features, they are a good indicator species for many of the wetland-dependent birds in the YBA.211 Given this this wetland dependency and the extensive wetland acreage (including woody wetlands) that will be adversely impacted by the Yazoo Pumps Alternatives, the model's conclusion that PROW impacts could be offset by just 1056 acres of bottomland hardwood reforestation is questionable, and at a minimum requires additional explanation. Understanding impacts to PROW is particularly important as the Yazoo Backwater Area has one of the most important concentrations of this species in the region (eBird relative abundance indices >1.2), on par with other critical places like Tensas National Wildlife Refuge. PROW populations have been increasing in the region between 2012 and 2022, despite the long-term 50-year trend that shows a 29% decline in PROW according to the U.S. Geological Survey Breeding Bird Survey, indicating the relative high value of the Yazoo Backwater Area in sustaining this species. Third, the DEIS migratory landbird analysis lacks transparency, making it difficult to assess the full range of the potential problems with the model, and the migratory landbird write-up is confusing. For example: • The landbird appendix refers to Acoustic Recording Unit data but does not explain the purpose of this data or how it links to the DEIS assessments. The appendix mentions many "thousands of hours" of recordings but does not provide information on what those recordings show or whether they are representative of species density. The appendix states that acoustic recording sampling between the 92.8- and 97.3-foot elevations was "representative" but does not explain how or why, and of course this does not include the area between 90 and 93 feet which will be extensively impacted by the Yazoo Pumps Alternatives. Moreover, the fact that there are many thousands of Prothonotary Warbler and Acadian Flycatcher detections above 93 feet suggests that the impacts to these species from reduced periodic flooding (i.e., long-term drying) above 93 feet may not be properly accounted for in the landbird model since the model suggests that there will be extremely limited impacts to these species above 93 feet, again calling into question the difference between the model outputs and estimated wetland drainage presented elsewhere in the DEIS. • The landbird appendix refers to a two-week late July visit to the region to detect bird species but does not explain how or why this was an appropriate time to collect such data, or how these surveys might contribute to an understanding of habitat impacts to landbirds. It is more likely that this was an inappropriate time to collect data as songbirds become quieter during this period as they tend to fledglings, molt, and prepare to migrate south. • The appendix states that "the YBA consists largely of agricultural lands with scattered remnants of BLH and cypress/tupelo swamps (Wakeley 2007)."213 This contradicts DEIS Table 3-3 which shows substantially more wetland forest than agriculture, at least below the flood inundation thresholds being evaluated in the DEIS. Table A-6 does not explain whether the "average" is the mean or the median, which can have significant implications for the interpretation of the data. Figures A-1, A-2, and A-3 document large gaps in the two large, forested blocks in the southern portion of the Yazoo Backwater Area without any corresponding explanation. Fourth, the DEIS does not assess or account for the impacts to migratory landbirds in light of the full suite of direct, indirect, and cumulative impacts that will adversely affect migratory landbirds that rely on the Yazoo Backwater Area. The DEIS may not properly rely solely on outputs from a migratory landbird model to assess landbird impacts, even if the DEIS used an appropriate model populated with accurate information. As a result of these many failings, the DEIS significantly understates migratory landbird impacts.	Golden-winged Warbler is a transient migrant passerine in this area that forages in the canopy or shrub layer and does not rely on backwater flooding. Periodic fluctuations in water depths would be unlikely to affect this species and, thus, it would not be an appropriate species to include in this analysis. As stated in the Waterfowl Appendix, the only year in which the pumps would have operated during the winter period would have been in 2020 (1 out of 43 years). Therefore, assessing impacts to Rusty Blackbirds would result in virtually no estimated impacts to the species. We agree that the Yazoo Backwater Area is important for Prothonotary Warblers and Acadian Flycatchers, and during 2023 and 2024 field work throughout a range of elevations we noted high abundances of both of these species throughout much of the Delta National Forest despite there being no backwater flood events that would have triggered initiation of pumping under the proposed plans (above 90.0 ft) since 2020. It is important to recognize that the model impacts are derived from Tirpak et al. 2009. The hydrological variable for both the Prothonotary Warbler for which the highest impacts occur, along with the lesser impacted Acadian Flycatcher are associated with distance to nearest inundated area. These inundated areas could be permanent features such as sloughs or other forested waterbodies or seasonally inundated areas such as currently managed greentree reservoirs and areas that experience backwater flooding. Areas that occur below the 2-year floodplain (i.e. below ~90.0 ft) will not be impacted by operation of the pump and will continue to experience backwater flooding and contribute strongly to habitat availability for these species. Furthermore, it is important to differentiate between "impacted" acres and required "mitigation" acres within the YBA modeled area. The wetland appendix does reference "impacted" acres in addition to mitigation acreage whereas the wildlife appendices did not include this metric. A hypothetical example where one acre under Alternative 1 (no pump implementation) with a Suitability Index score of 0.76 could be minimally impacted within the model under Alternative 2 to receive a SI score of 0.74. This minimal difference of 0.02 SI would be considered as 1 impacted acre but result in little mitigation acreage. However, the combined mitigation strategies for reforestation of bottomland hardwood forests as outlined as mitigation for Prothonotary Warblers, Acadian Flycatchers, and wetlands analyses will add 7,650 acres of habitat for a wide suite of warblers, flycatchers, and other passerines. The ARUs deployed in the DNF were deployed with the purpose of sampling the bird community across a wide range of elevations and serves only to add context to the analysis. 92.8-97.3 feet is an unfortunate typo in the draft appendix. Our ARUs were deployed across the entire spectrum of elevations within the DNF, from 84.5-97.6 feet. If anything, the number of ACFL/PROW detections at elevations well above the reach of all but the most extreme backwater events (i.e. 2019) demonstrates that even these wetland-associated species are in no way reliant on deep, prolonged backwater events. "Backwater" events above elevation 93 are infrequent upon the YBA landscape; however, local precipitation events strongly contribute to these wetlands continuing to maintain seasonal hydrology during most years. We have three years of ARU data from the month of May demonstrating that WOTH seem to be limited to the highest elevations within the DNF. The migratory bird analysis modeled those areas that could be impacted by operation of the pump within the YBA; therefore, forested areas below elevation 90 were not included in Figures A 1-3 since the suitability scores would remain the same among Alternatives 1, 2 and 3. Table A-6 which includes the "average" elevation during the March 15-July 31 timeframe is based upon the mean daily stage recorded over the POR at the Steele Bayou Landside gauge. The majority of the Yazoo Backwater is clearly agricultural land, especially the portion that is above 90.0 ft. We are unsure what you are suggesting as an alternative to modeling outputs as far as assessing impacts in a quantitative manner that enables calculations for incorporation into a mitigation strategy for migratory landbird habitat.
523	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	wildlife	The DEIS Does Not Assess Impacts to Amphibians and Reptiles The DEIS does not assess impacts to amphibians. The DEIS also does not assess impacts to 36 out of the 37 species of reptiles that rely on the Yazoo Backwater Area. This is an egregious failure that was highlighted as a fundamental problem in the Clean Water Act veto. The Conservation Organizations have repeatedly asked the Corps to fully assess the impacts to these vital species given the significance of the Yazoo Backwater Area wetlands and flood pulse for their survival, and the dire conditions facingthese species worldwide.248The 2008 Clean Water Act veto documents 21 species of amphibians and 37 species of reptiles in the Yazoo Backwater Area,249 virtually all of which "benefit from the flood pulse."250 The veto concludes that the Yazoo Pumps would adversely impact virtually all these species: "the proposed hydrologic alterations will adversely impact approximately 21 species of amphibians and 32 species of reptiles by disrupting their reproductive cycles and feeding opportunities and thereby reducing overall productivity."251 This is because: Reducing the spatial extent, depth, frequency, and duration of time wetlands in the project area are inundated will also adversely impact all 21 amphibian as well as 32 of the reptile species in the Yazoo River Basin that depend upon wetlands for breeding and foraging habitat. The life cycles of amphibians and reptiles in alluvial floodplain ecosystems are linked to hydrology as well as soil conditions and climate (Jones and Taylor, 2005). Abiotic factors that influence habitat conditions within floodplains include hydrologic regime, flood pulse intensity and duration, topography, wetland permanence (hydroperiod), water quality, and connectivity to rivers or streams. For many amphibians, the hydrology associated with floodplain wetlands is necessary for breeding and egg laying (Appendix 4). All the amphibian species listed as occurring in the Yazoo Backwater Area (Appendix 2) require wetlands and/or ephemeral pools for breeding (Jones and Taylor, 2005). The proposed project would reduce the amount of surface water that reaches these floodplain habitats making it difficult for portions of the amphibian population to survive (Semlitsch, 2005). For example, newts (Notophthalmus viridescens) require wetlands for breeding and egg deposition, while requiring vernal and ephemeral pools for adult life stages. The proposed project would also adversely affect reptile and amphibian species by reducing flood pulses and wetland water recharge, modifying river-wetland connectivity, and increasing habitat fragmentation. The reduction in flooding would also adversely affect the ability of amphibians to disperse to other suitable habitats (Jones and Taylor, 2005). Further, amphibians provide a valuable prey base for aquatic insects, fish, crayfish, birds, and mammals. Thus, a decline in amphibian and reptile populations will impact food resources for other animal groups.252 Amphibians thrive in cool wetland environments and small, isolated wetlands play especially important roles in amphibian productivity.253 Amphibian populations thrive when there are a variety of small ecosystems within a regional landscape in which a "dynamic equilibrium" of different populations becomes established.254 Habitat fragmentation can disturb this dynamic equilibrium by disruption patterns of amphibian emigration and immigration.The 2008 Clean Water Act veto further highlighted that: HEP does not evaluate the impacts of the proposed project on amphibians and reptiles. The FSEIS's HEP assessments exclude entirely any assessment of the proposed project's adverse impacts on amphibians and reptiles. Species in both of these classes of animals depend upon wetland habitat to meet numerous life history requirements and would experience extensive adverse effects from the proposed project. . . . Shorter duration and less frequent flooding will significantly and adversely affect the vegetation and aquatic animal communities within these wetlands, nutrient and sediment cycling, and other functions that establish and maintain the diversity of habitats critical for fish and wildlife dependent upon them, including waterfowl, shorebird, and wading bird foraging habitats, fish spawning and rearing habitats, and amphibian, reptile, and mammal habitats. . . . These reductions and losses in wetland functions were not adequately factored into the FSEIS's HGM and HEP assessments.255 As a result, it is critical that the DEIS carefully assess the impacts to amphibians and reptiles from the Yazoo Pumps Alternatives and then evaluate the implications of those impacts in light of the many dire conditions and threats facing amphibian populations in the United States and worldwide and other critical cumulative impacts including climate change.	The taxa included in this analysis were decided and agreed upon in conjunction with the USFWS and the EPA including a herpetologist with the USFWS.

Comment Number	Comment Date	Org.	Theme	Comment	Response
524	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	wildlife/water fowl	1. The DEIS Significantly Understates Impacts to Waterfowl (Appendix F-5) The DEIS analysis of waterfowl impacts significantly underestimates the impact of Alternatives 2 and 3 on waterfowl. Among other problems, this analysis is based solely upon an assessment of lost duck use days (DUDs) during the overwintering period of November 1 through February 28. According to the DEIS, this DUD assessment shows that the Yazoo Pumps Alternatives would result in the loss of 196,648 or 202,798 annual DUDs on average.161 However, at best, this provides just a partial picture of the damage to waterfowl, including because: (a) The DEIS does not assess impacts to breeding waterfowl, which include the Wood Duck and Hooded Merganser. DUDs typically are not used to assess impacts to breeding waterfowl, and the DEIS waterfowl assessment relied on a DUD manual that acknowledges that it does not provide energy needs for breeding waterfowl.162 Other methods, however, are available for assessing impacts to breeding waterfowl. (b) The DEIS does not assess impacts to migrating waterfowl, including for the economically important Blue-winged Teal, because it fails to consider or quantify impacts from mid-August through October, and again in March through mid-April. (c) The DEIS does not assess or account for multiple adverse impacts to waterfowl, including highly significant cumulative impacts, and many of the impacts analyses that are carried out are fundamentally flawed. d) The DEIS may not rely solely on DUD model outputs to identify needed mitigation because the model can at best provide an estimate of relative loss, it does not provide a precise prediction of lost duck use days. Because of these many failings, the mitigation that has been proposed to offset waterfowl impacts is not sufficient—even if the limited amount of mitigation proposed could somehow replace all lost functions and values critical to waterfowl, which it cannot.	As stated, the waterfowl analysis was selected to evaluate loss of duck-use-days during the winter period (November through February) when the largest majority of waterfowl are present. The DUD model selected for this analysis was agreed upon by USACE, USFWS, and EPA. The analysis resulted in minimal mitigation acreage because of the lack of difference between hydrology among the alternatives (Alternative 1-3). As stated in the waterfowl appendix, the only year during the POR that would have resulted in pump operation would have been during 2020. Even though 2021-2024 was not included in the POR, it can be noted that pump operation during the winter waterfowl period would not have occurred in these years as well. Previous fieldwork in the Delta National Forest determined that much of the forest is comprised of trees that do not produce mast used by waterfowl, with only oaks comprising approximately 24 percent of the forest community 10 centimeters diameter at breast height (dbh) or greater within our plots. Even with oaks occurring within the forested community, not all oaks produce acorns suitable as a food source for waterfowl due to their large size (e.g. overcup oak). We used the conservative approach for habitat in that we used the naturally forested BLH with average density of small, medium, and large trees to account for food resources within flooded forests. Using this approach almost certainly overestimates the food resources within flooded forest in the YBA, but provides a conservative measure that accounts for the highest impacts (and mitigation) between the Alternatives. The recommendations for reforestation to meet flooded conditions for foraging waterfowl along with a diversity of oak species that produce mast suitable for waterfowl will almost certainly provide a higher resource level than what currently exists on the landscape given the high percentage of non-mast producing trees in areas.
525	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	wildlife/water fowl	(a) The DEIS Does Not Assess or Account for Impacts to Breeding Waterfowl The DEIS does not assess or account for impacts to waterfowl during the critical breeding season. Instead, the DEIS bases its entire analysis of waterfowl impacts on lost DUDs during the overwintering period of November 1 through February 28.163 This is an egregious omission because the Yazoo Backwater Area is an important breeding area for waterfowl, and particularly for Wood Ducks and Hooded Mergansers. Impacts to breeding waterfowl are fully acknowledged in the Clean Water Act veto: The proposed project could also affect resident breeding waterfowl, such as wood ducks (Aix sponsa) and hooded mergansers (Lophodytes cucculatus) (Kaminski, 1998). Both duck species breed in Mississippi and nest in natural tree cavities or artificial nest boxes. Reduced flood pulses in the spring could adversely impact nesting and brood rearing in these birds. These species depend heavily on food resources derived from shallowly flooded forested wetlands (Heitmeyer et al., 2005) and will move their broods to newly flooded bottomland hardwood areas flooded by spring and summer flood pulses, to take advantage of the available plant and animal foods (Kaminski, 1998). Reduction in flooding, due to the project, would adversely impact food resources for these breeding waterfowl (Appendix 4). The proposed project would reduce the extent of flooding within wetlands in the 2- to 5- year floodplain potentially from January through June. The reductions to late winter and spring flooding would result in significant adverse impacts to those birds which not only utilize the Yazoo Basin, but are dependent upon backwater flooding during these periods (Table 5). As discussed above, species that require flooded habitat for foraging and/or nesting would obviously be the most severely affected. The reduction in the extent and duration of the spring flood pulse would accelerate the decline of many bird species that depend upon the wetland habitats of the lower Yazoo River (Appendix 4). Critically, as acknowledged in the Clean Water Act veto: Population size and recruitment of most species of waterfowl are correlated with wetness of primary breeding habitats, and, at least for some species, also migration and wintering habitats. Breeding waterfowl also have unique energetic needs that are different from those required by overwintering waterfowl. For example: The wood duck is an important resident species in the Yazoo River Basin. Wood ducks require wetland areas that provide a high-quality plant and invertebrate food base. During the breeding season, female wood ducks may use stored lipid reserves to assist with egg production; however, they must consume essentially all of the protein needed for egg formation on a daily basis during the laying period (Drobney, 1977). The required source of most of these proteins is a variety of invertebrates produced in these wetland habitats. To assess impacts to breeding waterfowl, the DEIS must analyze and account for project-induced impacts during the breeding season—when water levels will be held at their lowest levels—and the unique food sources and energetic needs of breeding waterfowl. As noted above, the Yazoo Backwater Area is particularly important for wood duck nesting and rearing. However, Alternatives 2 and 3 will keep water levels at or below the 2-year floodplain precisely when the area wetlands are needed for reproduction. The project-included impacts to wetlands from March through May would impact Wood Duck nesting, whereas project-included impacts to wetlands from June through July could affect Wood Duck broods and post-breeding (molting) females. A diversity of wetland types and water level conditions are needed across space and time during the breeding season to support resilient populations, whereas controlling water levels to not exceed 90 feet will add homogeneity to the landscape while reducing the availability suitable habitat. The wholesale failure to assess impacts to breeding waterfowl renders the DEIS inadequate and prevents decision makers from being able to rely on the DEIS to make a reasoned choice among alternatives. The final EIS must assess impacts to breeding waterfowl. To do this, DEIS could use methodologies similar to those used in the other bird models, such as a Habitat Suitability Index approach, which are available for both Wood Duck169 and Hooded Merganser,170 but ideally would use more advanced methodologies.	Abundant permanent water sources as well as seasonally inundated depressional areas (including green tree reservoirs and managed impoundments) occur throughout the YBA, particularly the Delta National Forest and Yazoo National Wildlife Refuge. Furthermore, as explained in the Appendix and in other responses, backwater flooding would also continue to occur up to 93 ft in the non-crop and 90 ft in the crop season with the same frequency as baseline (no pump) conditions, and elevations above 90 ft are not reliably flooded under current or recent conditions as they have not flooded in the majority of years going back to 1978. As mentioned, Wood Ducks and Hooded Mergansers are cavity nesters with abundant nest locations in proximity to flooded waterbodies. Brood-rearing habitats were not directly addressed for these species; however, the brood-rearing period does coincide with other wildlife analyses in forested environments such as with the wading bird appendix and mitigation to offset loss of flooded acreages (in years in which the pumps would run) for wetlands, wading birds, and landbirds including Prothonotary Warblers (i.e., adding over 7,000 acres of bottomland hardwood forest) would benefit Wood Ducks and Hooded Mergansers as well . As noted in that appendix and numerous other places within the DEIS, the June through July hydro-period would experience little differences between Alternatives based on the POR. Ducks Unlimited estimates an annual population increase for Wood Ducks in the Mississippi Flyway of 1.5%. Breeding Bird Survey data shows that Wood Ducks and Hooded Mergansers (the latter of which are uncommon breeders in the YBA) have been increasing in population throughout North America in recent decades. As stated previously, all wildlife analyses were agreed upon between USACE, USFWS, and EPA. It is not feasible to evaluate all species, but to ensure adequate analyses are conducted to mitigate for the overall ecosystem within the YBA.
526	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	wildlife/water fowl	(b) The DEIS Does Not Assess or Account for Impacts to Migrating Waterfowl The DEIS does not assess or account for impacts to waterfowl during the critical spring and fall migration seasons. Instead, the DEIS bases its entire analysis of waterfowl impacts on lost DUDs during the overwintering period of November 1 through February 28.171 This is an egregious omission since the Yazoo Backwater Area is an important stopover area for waterfowl that migrate through the Mississippi River Flyway during the spring and fall migrations. Because of this unacceptable omission, the DEIS: -Does not provide any information on impacts during spring migration, when 1.49 million waterfowl migrate through the Yazoo Backwater Area; and • Does not provide any information on impacts during fall migration, when 1.32 million waterfowl migrate through the Yazoo Backwater Area. At least sixteen different species of waterfowl rely on the Yazoo Backwater Area during migration, including economically important species like the Blue-winged Teal, which migrates through the region particularly early in the fall and late in the spring. To properly assess impacts to migrating waterfowl, project-induced impacts must be assessed during the spring migration and fall migration seasons—when water levels will be held at their lowest levels—and must properly account for the unique food sources and energetic needs of migrating waterfowl.172 For example, during spring migration waterfowl must accumulate both the resources they need to fuel their northward migration and the resources they need to carry over into egg laying production which will affect breeding productivity. The energetic demands of waterfowl in spring are thus considered the most limiting period in the life cycle of waterfowl, and this period has a disproportionate effect on population change. Population size and recruitment for some waterfowl species "are correlated with wetness" of migration habitat, as recognized in the Clean Water Act veto. The Yazoo Backwater Area is particularly critical to migratory waterfowl from early March through mid-April (spring migration) and mid-August through late October (fall migration). To assess impacts during this period, the DEIS must assess impacts during both migratory seasons using appropriately protective energetic values. Under the current DUD assessment, approximately 124 days of migratory impacts are not assessed.	As stated previously, based on the POR the fall migration period will not be impacted as the pump would not be operational. As to the statement that "To properly assess impacts to migrating waterfowl, project-induced impacts must be assessed during the spring migration and fall migration seasons—when water levels will be held at their lowest levels", it is important to note that in many years the levels of 90 are not reached (and pumps would not be operational). However, significant habitat still remains on the landscape due to local precipitation events that should be distinguished from "backwater" events. See previous comment for additional analyses agreed upon by cooperating agencies and other species assessments to assess ecosystems in the YBA.
527	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	wildlife/water fowl	(c) The DEIS Does Not Assess or Account for Multiple Adverse Impacts to Waterfowl The Corps may not properly rely solely on an assessment of lost DUDs (even one that fully addresses the problems highlighted above). To the contrary, the DEIS must assess waterfowl impacts in light of the full suite of direct, indirect, and cumulative impacts. As highlighted in the Clean Water Act veto: The impacts to waterfowl are related to long-term, adverse impacts to spring breeding and rearing habitat for species such as the wood duck and hooded merganser, as well as the reductions in spring flooding that ultimately, over time, alter the flora and fauna that waterfowl depend on during the breeding and wintering period	It is true that the waterfowl assessment focused on the winter period which is the time most waterfowl are present in the YBA. While we did not access breeding habitat for the Wood Duck and Hooded Merganser within the YBA, components to their successful breeding undoubtably overlap with other analyses such as hydrology within the wading bird appendix. As stated previously, it is not feasible to model every species that occurs in the YBA but rather take an ecosystem approach that covers resources to those that inhabit this system. The interagency approach of deciding on which species and models to include in the YBA EIS attempts to cover most species within the ecosystems present in the YBA.

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528	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	wildlife/water fowl	(e) The DEIS May Not Rely Solely on DUD Model Outputs to Identify Needed Mitigation The DEIS may not rely solely on the DUD Model outputs to identify needed mitigation Because the model can at best provide an estimate of relative loss and not a precise prediction of lost duck use days. The DEIS relies entirely on lost DUDs to identify needed mitigation. This is not appropriate because at best, a DUD model will provide an estimate of relative losses. Even a perfectly implemented DUD model will not provide a precise prediction of lost duck use days. For example, the DUD model relies on a series of estimates that offer an unknown amount of precision and error to predict current and future conditions in the Yazoo Backwater Area, as documented in the Corps' May 2010 "Manual for Calculating Duck-Use-Days to Determine Habitat Resource Values and Waterfowl Population Energetic Requirements in the Mississippi Alluvial Valley." For example: Estimates of food abundances reported in the field studies considered in this manual often varied substantially, and ranges of values and error probability were not always reported. This manual provides estimates of food abundance and availability to be used in model equations based on statistical means/medians of similar studies and/or data from more comprehensive and long-term investigations. For some foods and habitats, few data/studies were available and estimate values were chosen based on assumed relationships of other similar foods or habitats. . . .Consequently, it is difficult to suggest exact probability values, such as standard of errors, for the selected estimates of specific foods and habitats. The 2010 DUD Manual thus makes clear that uncertainties remain regarding how to measure food production of various habitats, which also varies by season and geography. This adds to the uncertainties in the model's output of DUD estimates. The DUD model also requires multiple project specific inputs, which may themselves be based on estimates: Project-specific information including number and species of waterfowl present; area, type, and management of habitats; composition, density and size of trees in forested habitats; and occurrence, frequency and duration of flooding by area and habitat type is required prior to using the model equations provided in this manual. Errors in any of the many required inputs will contribute to uncertainties in the model's outputs. As a result, although relative losses in DUD can be calculated to inform mitigation, mitigation based on calculated DUD losses cannot ensure full mitigation of impacts (even if that mitigation was 100% successful in replacing lost functions and values) Many additional problems with the proposed waterfowl mitigation are discussed throughout this Section and in Section L of these comments. Notably, these problems are not nullified or offset in any way by the Corps' completely unsupported hypothesis that the "potential for creating moist-soil management units using structural means or green-tree reservoirs along with enhancing bottomland hardwood forests (BLH) will more than offset the loss of foraging habitat to wintering waterfowl in the Yazoo Basin with proper mitigation to compensate for the loss of DUD under the Water Management Plan." The Conservation Organizations also note that the DEIS creates confusion and inappropriate burdens on the reviewing public by including two separate Waterfowl Appendices—Appendix F-5, which is discussed below; and Appendix F-4, D. These appendices also create confusion including by such things as failing to properly clarify whether the amount of proposed mitigation is required annually or over the life of the project, utilizing tables with confusing formatting, and presenting graphs without axis labels, among other things. These appendices create additional confusion by using different labels for the same alternative. For example, the two waterfowl appendices variously describe both the No Action Alternative and the alternative with a crop season that runs from March 25-October 15 as Alternative 1182 and the alternative with a crop season that runs from March 15-October 15 as Alternative 2. By comparison, the DEIS Main Report refers to Alternative 1 as the No Action Alternative, Alternative 2 as having a crop season of March 16-October 15, and Alternative 3 as having a crop season of March 25-October 15. As discussed throughout these comments, the DEIS does not assess a wide array of highly relevant direct, indirect, and cumulative impacts. For example, the DEIS does not evaluate the cumulative impacts of climate change which are particularly significant for migratory species and does not evaluate the cumulative impacts of habitat loss throughout the waterfowl species' migratory routes. This full array of impacts must be accounted for in assessing the highly significant impacts of Alternatives 2 and 3 on waterfowl that rely on the Yazoo Backwater Area.	As discussed previously in comments and within the waterfowl appendix, conservative approaches on habitat types listed within the 2010 Duck-Use-Day Manual were used in the analysis such that impacted areas would be over rather than under-mitigated. Forested habitats are the primary areas used by wintering waterfowl within the YBA and conservative values that are weighed towards forests containing a higher percentage of mast-producing species rather than floodplain or riverfront forest were used for this conservative approach. A more in-depth analysis of actual forest composition would result in a lower mitigation value. Mitigation acreage flooded at the recommended depth with a diversity of oak species will be created for use by waterfowl every year during the winter period for the 50-year life of the project. Given the mitigation acreage for the YBA as a result of the Wetland analysis, not only will impacts be offset by the mitigation, but many additional acres will become available to wintering waterfowl.

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529	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	wildlife/water fowl	2. The DEIS Shorebird Analysis is Fundamentally Unreliable (Appendix F-4, B) The DEIS incorrectly assesses impacts to shorebirds.185 This is an egregious error because the Yazoo Backwater Area provides vital shorebird habitat during the spring and fall migration, as highlighted by the Clean Water Act veto Approximately 6.6 million shorebirds from 17 species migrate through the Yazoo Backwater Area in the fall, while 2.8 million migrate through the Yazoo Backwater Area in the spring, according to Audubon's analysis. More than 10% of the continental population of several of these shorebird species rely on the Yazoo Backwater Area. This diverse suite of birds depends on often ephemeral habitat resulting from wet-dry cycling that produces high concentrations of invertebrates. All these species prefer moist soil and shallow water, although a few species will also sometimes feed in dry grassy habitats (e.g., American Golden-Plover). Despite the unquestionable importance of the Yazoo Backwater Area to shorebirds, the DEIS suffers from critical flaws that render its shorebird assessment fundamentally unreliable. A number of these flaws are highlighted below. First, the DEIS does not properly identify187—or assess the impacts to—shorebird species that are more reliant on the Yazoo Backwater Area. Based on the Audubon analysis, the region is most important for the species listed below. More than 1% of continental populations of the species on this list that are highlighted in blue rely on the Yazoo Backwater Area during both the spring and fall migration: • >5% of continental population in spring: Pectoral Sandpiper, Lesser Yellowlegs, American Golden-Plover, White-rumped Sandpiper, Stilt Sandpiper, Least Sandpiper, Semipalmated Sandpiper, Greater Yellowlegs • 1-5% of continental population in spring: Long-billed Dowitcher, Dunlin, Short-billed Dowitcher, Solitary Sandpiper, Semipalmated Plover • >5% of continental population in fall: Least Sandpiper, Pectoral Sandpiper, Long-billed Dowitcher, Stilt Sandpiper, Lesser Yellowlegs, Semipalmated Sandpiper, Short-billed Dowitcher, Black-necked Stilt, Western Sandpiper • 1-5% continental population in fall: American Avocet, Solitary Sandpiper, Semipalmated Plover, Wilson's Snipe, Spotted Sandpiper. Second, the DEIS relies on a shorebird model that does not—and cannot—capture the important nuances in shorebird habitat requirements. For example, migratory shorebirds have unique habitat needs because they are highly transient, with individual birds stopping only as long as they need (a few days to a few weeks) to continue migrating. Thus, to provide a meaningful analysis, a shorebird model must be able to assess whether habitat will be available at the times when these shorebird "waves" pass through the Yazoo Backwater Area. To provide a meaningful analysis, a shorebird model also must be able to assess whether the highly ephemeral food sources that shorebirds rely on will be present in those available habitats when these shorebird waves pass through. These food sources are generated by repeated cycles of flooding and drying, so the model must be able to account for the transient presence or absence of water on the land during these cycles. Models that can assess these nuances are available, including the model presented in Twedt (2013)188, and should be used to assess the impacts of the Yazoo Pumps Alternatives on shorebirds. Third, the Corps parameterizes its already inappropriate shorebird model with severely flawed assumptions that do not reflect the ecological needs of migratory shorebirds. This makes the shorebird model outputs fundamentally unreliable. For example, the Corps' shorebird model only provides a binary choice of habitat suitability, with suitable habitat having an "average" water depth of 0.0 – 0.7 feet. Among other problems, by including an "average" water depth of 0.0 feet as suitable, the model is accounting for dry land as suitable shorebird habitat. But dry land is not shorebird habitat. Relying on average water depths also means that the model cannot account for the crucial importance of ephemeral habitat. By failing to indicate whether the "average" represents a mean or median, the DEIS creates additional problems for interpreting the accuracy of the model outputs. The model's reliance on averaging (i.e., combining) impacts between spring and fall, is a critical and fundamental failing. By averaging spring and fall impacts, the model is not able to identify the impacts of the Yazoo Pumps Alternatives on shorebird during the most critical and limiting period of the shorebird life cycle—fall migration. Understanding the fall migration impacts is essential to accurately assessing shorebird impacts because the region's fall migration habitat is extremely limited at the precise time that it is most needed by the extremely large number of shorebirds that migrate through the area during that time. Approximately 6.6 million shorebirds from 17 species migrate through the Yazoo Backwater Area in the fall when habitat is the most limited: "shallow-water habitats during the southern migration period of shorebirds are extremely limited in the Mississippi Alluvial Valley, and early fall habitat is generally more limited than is late fall habitat."189 During the spring, when more shorebird habitat is available190, approximately 2.8 million shorebirds migrate through the Yazoo Backwater Area. Fourth, the shorebird model relies on outputs from the EnviroFish model. Indeed, the EnviroFish model outputs are foundational to the shorebird model.191 As a result, the shorebird model will be infected by any problems with EnviroFish, including those identified in Section G of these comments. Fifth, to fully analyze shorebird impacts, the model would also need to evaluate the loss of shorebird habitat that would arise from those elements of the proposed compensatory mitigation that would reforest low elevation agricultural lands that currently provide shorebird habitat, because shorebirds will not use forested habitats. Sixth, the DEIS shorebird analysis lacks transparency, making it difficult to assess the full range of the potential problems with the model. For example, the DEIS provides little information on this functionality, and the Conservation Organizations were unable to locate the report on the "Shorebird Migration Model" referred to the DEIS despite an extensive search. The "in-house" hydrology layers referenced in Table B-2 also are not available for the public to review. The write-up of the shorebird model also creates confusion. For example, it is unclear whether the Shorebird Appendix concludes that 403 acres of shorebird habitat are needed each year or whether that amount is needed cumulatively over the life of the project. It is also unclear whether mitigation has been assessed over a 50-year project life or over the 43-year period of record which is what the math in Table B-6 suggests. It is unclear when (i.e., fall and/or spring) and how mitigation for lost Habitat Units would be implemented. The DEIS also uses multiple different labels to describe the same alternative. Seventh, the Corps may not properly rely solely on outputs from a shorebird model to assess shorebird impacts, even if the DEIS used an appropriate shorebird model populated with accurate information. The DEIS must assess and account for shorebird impacts in light of the wide array of direct, indirect, and cumulative impacts that will adversely affect shorebirds and the Yazoo Backwater Area. Cumulative impacts to habitat throughout a species' migratory route and the cumulative impacts of climate change are particularly significant for migratory species, including migratory shorebirds. This full array of impacts must be accounted for in assessing the highly significant impacts of Alternatives 2 and 3 on the shorebirds that rely on the Yazoo Backwater Area. As a result of these many failings, the DEIS assessment of shorebird impacts is fundamentally unreliable.	Under the pumping alternatives, the YBA will continue to serve as important stopover habitat for shorebirds during the spring and fall migration. It is important to note that much of the habitat that is created from wet-dry cycling in this area is caused from precipitation events in areas with microtopography that allow for temporary ponding of water at shallow depths. These areas are completely independent of any "backwater" events. In fact, based on the proposed pumping parameters and the period of record (POR), had the pumps been in operation, they would not have operated during the fall migration season which is why it is not included in the analysis. In the future, water levels likely will never reach sufficient heights during this season to initiate pump operation. We used a liberal definition of shorebird habitat that pertains to a broad swath of shorebirds. By staying broad in our definitions, we are actually being liberal with defining pertinent habitat. Drilling down to species level would only decrease the quantity/quality of what we defined as shorebird habitat. It is important to note, that in many years during the POR the pump would not have operated, resulting in uniform hydrological conditions between Alternatives 1, 2, and 3. The proposed mitigation that will be established will be managed in a way that provides shorebird habitat every year, both spring and fall. We have not included any benefits that mitigation will provide during fall migration as the analysis only includes spring migration (again, pumps should not operate during fall migration period based on historical records during the entire POR). While it is true that our model may be relaively simplistic, if anything it is generous to shorebirds in its simplicity. It uses broad definitions for shorebird habitat and likely includes areas that would not be used by shorebirds, such as areas that have been inundated too long, areas that have not been inundated long enough, and areas where the inundation is too deep (i.e. Least Sandpiper would not forage in 6 inches of water). It also assumes all agricultural areas to be shorebird-friendly habitat, which is very demonstrably not true. Many agricultural fields have dense cover crop outside of the growing season that would preclude shorebird foraging. If we were to adopt a more complex, more nuanced model, it would likely only lead to a decrease the amount of estimated shorebird habitat lost between the alternatives, and thus result in less mitigation. The suitable water depth for shorebirds did not include dry (0.0 water depth) land. Suitable water depth was >0 and <= 0.7 ft. We have added some clarification for the FEIS. Had the pumps been in operation over the entire POR, they would have been turned on only once after June 20 over the past 47 years, thus, and thus the fall portion of the model is nearly identical between alternatives. Regardless, averaging spring and fall in no way would diminish conclusions regarding the value of an area to shorebirds in fall. The model simply attempts to quantify the value to shorebirds during spring and the value to shorebirds during fall, and then averages these values to give a value that represents the overall value to shorebirds during both spring and fall. But again, because the likelihood of pump operation in fall is exceedingly low, shorebird suitability in fall is uniform across the alternatives. For this reason, we excluded the fall portion of the habitat suitability model. This is advantageous to shorebird mitigation, as including the fall portion of the model would effectively constrict the differences in habitat quality between the alternatives and result in a lower mitigation score and a reduced recommendation of mitigation acres. From 1979 through August of 2024, the pumps would have run in 20 out of 47 years and thus in the majority of years the hydrology would be unchanged. While no hydrological model is perfect, for years in which backwater flooding exceeded the 90.0 and 93.0 ft thresholds during crop and non-crop seasons, the EnviroFish model provided useful estimates of flooded acreages differences between the no-action and pumping alternative scenarios to inform the shorebird assessment. Without any final determination on mitigation placement, it is impossible to accurately account for loss of low elevation agricultural lands. USACE position as related to mitigation for shorebirds is as follows: Mitigation is a means to compensate for unavoidable impacts over the project life. Mitigation is not based on any one species or assemblage of a type of species such as shorebirds. It is based on unavoidable functional impacts from an ecosystem and adequately replacing those unavoidable ecosystem functional losses. Suitability scores reflect an overall functional value, based on a collection of different species, assemblages, and uses. Shorebirds inhabit the area more frequently now only because the bottomland hardwoods that were on the land have been cleared due to agricultural activity (Li et al 2023). Mitigation is a means to attempt to restore/replace/create natural habitat that occurred prior to alteration. Therefore, there would be a significant amount of bottomland hardwood/riverfront forest mitigation. The mitigation plan would restore habitat to a historic condition. The issue regarding conflicting resources for ecosystem restoration projects or compensatory mitigation is not uncommon. Restoring benefits for one resource usually comes at a cost to another. Sparks (1995) recognized this problem of impacts to different species and groups of animals and their human advocates. Sparks further stated that the goal of ecosystem management should be to maintain and recover the biological integrity of the ecosystem. Biological integrity was defined as "the capability of supporting and maintaining a balanced, integrated adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of a natural habitat of the region (emphasis added)" (Angermeier and Karr 1994, Sparks 1995). Leveled cleared farmland does not fit the definition of "natural habitat of the region." Proposed mitigation for other resources would restore the natural habitat of the region. Additional mitigation for shorebird habitat stemming from bottomland hardwood forest mitigation implementation would not be required. ERDC is, and has been, willing to provide the Clark and Jordan shorebird model publication at any time, as well as all spatial layers utilized in this analysis. The 403 acres of shorebird habitat is to be provided for every year over the 50-year lifespan. This number comes from the 352 HUs lost annually (difference in HUs between No-action and pumping alternatives), divided by the mitigation HUs per acre (0.874). Details regarding mitigation timing have not been determined, but ERDC recommends shorebird mitigation areas be available in both spring and fall. Cumulative impacts from conditions encountered across migratory shorebirds' full migratory routes would be difficult and likely impossible to fully account for in any local biological assessment. As such, we addressed changes (between baseline and proposed alternative pumping scenarios) in potential habitat amount and quality within the project boundary for shorebirds and other migratory taxa and based mitigation recommendations on changes in habitat availability within the Yazoo Backwater Area that apply equally to birds traveling through the Yazoo Backwater regardless of conditions encountered throughout the rest of the American continents.

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530	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	wildlife/water fowl	3. The DEIS Significantly Understates Impacts to Wading Birds (Appendix F-4, C) The DEIS significantly understates impacts to the region's important populations of wading birds193, including by basing its entire assessment on potential impacts to a single unrepresentative species during a single stage of its lifecycle. Multiple problems with the DEIS wading bird analysis are highlighted below. First, the wading bird analysis is flawed because it relies on just a single, unrepresentative species—the Great Blue Heron (GBHE)—to assess impacts to the region's important populations of wading birds. The GBHE is not an appropriate umbrella (or surrogate) species for other wading birds because the GBHE utilizes a wide variety of foraging habitats. As a result, the loss of subcomponent of GBHE niche habitat space might have only minimal effect on GBHE even though it could cause highly significant impacts to the wide array of species the GBHE was chosen to represent. This problem is highlighted in meta-analyses of the umbrella species concept because "some species are inevitably limited by ecological factors that are not relevant to the umbrella species." Critically, the DEIS uses GBHE to represent species that the GBHE in fact does not represent, including species that are highly reliant on the Yazoo Backwater Area such as the ibis, Little Blue Heron, Snowy Egret, Yellow-crowned Night Heron, and Tricolored Heron. During the fall, the Yazoo Backwater Area supports: 4.3% of the continental population of Snowy Egret; 9.2% of the continental of Yellow-crowned Night Heron; and 3.7% of the continental population of the Tricolored Heron The selection of the GBHE as the umbrella species also violates important criteria for selecting an umbrella species which include rarity, sensitivity to human disturbance (e.g., habitat alterations), and relative co-occurrence with other species for which it is an assumed proxy.196 However, the GBHE is neither rare nor particularly sensitive to habitat modifications in comparison to many other wading bird species. The DEIS offers no quantitative measures or description of how or why the GBHE was chosen as the umbrella species. Second, the DEIS only analyzes impacts to GBHE habitat during a single stage of its lifecycle: the breeding season. The DEIS does not analyze or consider impacts to GBHE or any wading bird habitat during other periods of the life-cycle, including the critically important: (1) post-breeding season, typically from July through early September when waterbirds and especially young birds will travel north/northeast in search of flooded wetlands—during this period water on the landscape is limiting, and water would be further limited by the seasonal pumping scenarios of the Yazoo Pumps Alternatives; (2) fall migration from September through mid-November; and (3) over-wintering period from November through mid-March. Impacts during these other periods could be significant. For example, by keeping water levels at or below 90 feet during the late-summer the Yazoo Pumps Alternatives could cause substantial impacts to critically important populations of several species of wading birds that are heavily reliant on the Yazoo Backwater Area, including the Snowy Egret, Yellow-crowned Night Heron, and Tricolored Heron. Third, the DEIS infuses an inappropriate bias into its analysis by irresponsibly suggesting—without any factual support whatsoever—that there may be unaccounted for benefits to wading birds from the Yazoo Pumps Alternatives.197 This suggestion is even more unacceptable because the DEIS does not consider impacts to wading birds outside of the nesting season, which could significantly offset any such unsupported benefits, as discussed above. Fourth, the wading bird model relies on outputs from the EnviroFish model. Indeed, the EnviroFish model outputs are foundational to the wading bird model.198 As a result, the wading bird model will be infected by any problems with EnviroFish, including those identified in Section G of these comments. Fifth, the DEIS wading bird analysis lacks transparency, making it difficult to ass the full range of the potential problems with the model. For example, the DEIS fails to provide an explanation of why it is appropriate to use the National Elevation Dataset instead of the more up to date USGS 3D Elevation Program (3DEP). The DEIS fails to explain why there is an order of magnitude difference in flooded acres under the mean versus the median. It is also not clear which (median or mean) was used in the HSI model, and the biological and analytical implications of using one over the other is critical for interpreting potential impacts. Additional points of confusion in the wading bird section include the lack of x- and y-axis labels in Figure C-3, and Table C-6 is missing site numbers (#6 and #7). As iterated elsewhere in our comments, the general incomplete and draft presentation of this and other sections in Appendix F-4 suggests a lack of thorough attention and review. Sixth, the Corps may not properly rely solely on outputs from a wading bird model to assess shorebird impacts, even if the DEIS used an appropriate wading bird model populated with accurate information. The DEIS must assess and account for wading bird impacts in light of the wide array of direct, indirect, and cumulative impacts that will adversely affect wading birds in the Yazoo Backwater Area. This full array of impacts must be accounted for in assessing the impacts of Alternatives 2 and 3 on the wading birds that rely on the Yazoo Backwater Area. As a result of these many failings, the DEIS significantly understates wading bird impacts.	Great Blue Heron was selected as a representative species from the wading bird group after consultation with the USFWS, and as noted in the DEIS there is not perfect overlap of habitat, although there is overlap of habitat used by Great Blue Herons and other wading bird species. The HSI model used known rookery colonies, most of which harbor not only nesting Great Blue Herons, but also other wading bird species. Thousands of white wading birds are visible at some of these rookery locations in satellite imagery. And, historic counts, eBird checklists, and recent field visits verify that a suite of heron and egret species often nest together in the YBA. Furthermore, and most importantly, our broad definition of foraging habitat as all shallow water up to 18" for foraging habitat as a model input includes the ranges of potential foraging habitat for smaller egrets and herons, when in actuality the area and quality of habitat (for any wading bird species including GBHE) is likely less than what was modeled, thus our impact assessment was conservative in that actual areas used by Great Blue Herons and smaller egrets and herons is likely less than the model output implies. As such, more specialized models for each of the smaller wading bird species would yield lower habitat suitability indices and therefore would indicate less habitat loss (in years in which pumping would occur) due to the proposed pumping plans. Again, these smaller species do not forage in deeper water than Great Blue Herons. Thus, specialized models with a lower water depth would yield less habitat (and mitigation) acreage than the 18" threshold we used. We considered all water up to 18" depth as potential foraging habitat for Great Blue Herons and other wading birds. Snowy Egrets, Yellow-crowned Night Herons, and Tricolored Herons do not typically forage in deeper water than Great Blue Herons. And as for the fall counts, as detailed in the DEIS the pumps would have minimal if any effect during the fall season as water levels exceeding 90.0 ft have only occurred once after June 20 over the past 47 years (through Aug 2024), and in the majority of years the pumps would not be turned on at all at any point during the calendar year. In the extreme flood event of 2019, the pumps would have run until August 1 and there would have been more water on the landscape compared with an average year even had the pumps been running. The pumps would have run only once after June 20 in any calendar year over the past 47 years. And, in the DEIS, it is mentioned that the analysis includes the "core nesting and post-breeding season (Mar15-Jul31)" which coincides with the vast majority of occurrences over the past 47 years in which pumping would have occurred. While there are many wading birds in the YBA in August and in the autumn migration season, there would be negligible effects attributed to the proposed pumps compared with effects during the Mar15-Jul31 season. The post-breeding, non-breeding and early breeding periods combined from August through mid-March have much-reduced frequency of pump-on events (only 3 years out of the past 47 years, one of which would have lasted only 4 days in January), in part due to annual rainfall patterns and in part due to the threshold of pumping increasing in October during this period (coinciding with the non-crop season) being increased to 93.0 ft under the proposed pumping alternatives. It is important to note that the YBA serves as important habitat in years in which the pump would have never operated during the POR, this is because of the importance of local precipitation events combined with microtopography that allows for suitable habitat conditions for waterbirds during the numerous years without backwater flooding events that surpass 90.0 ft. See above comments regarding pump-on frequency outside of the nesting season. Furthermore, there absolutely is factual support suggesting that there may be unaccounted for benefits for wading birds, and we completely disagree with the assertion that mentioning the possibility of potential benefits (which we did not factor into mitigation calculations) is irresponsible. In 2019 and 2020, for example, vast areas that surround established breeding colonies of Great Blue Herons and other wading birds were flooded at depths greater than the heights of the birds for extended periods during the nesting and post-fledging periods. Herons and Egrets typically do not dive for prey, food sources would have likely been much less concentrated and likely more difficult to locate in turbid flood conditions, and there is also published evidence in the peer-reviewed literature that extreme flooding events have indeed been detrimental to the demographics of Great Blue Heron colonies in the upper Mississippi, as explained and cited in the DEIS. There is also evidence that prolonged backwater flooding leads to increased levels of methylmercury, which has also been demonstrated to bioaccumulate and negatively affect Great Blue Herons. We believe that discounting any possibility of potential benefits would be an inherently biased wildlife assessment. From 1979 through August 2024, the pumps would have run in 20 out of 47 years (20 of 43 years over the 1979-2020 period of record that was used in hydrological modeling) and thus in the majority of years the hydrology would be unchanged and thus it is clear that wading birds are not reliant on backwater flooding above 90.0 ft on an annual basis. While no hydrological model is perfect, for years in which backwater flooding exceeded the 90.0 and 93.0 ft thresholds during crop and non-crop seasons, the EnviroFish model provided estimates of flooded acreage differences between the no-action and pumping alternative scenarios to inform the wading bird assessment, and our wildlife team was not provided with any alternative hydrological models. The widely used USGS National Elevation Dataset provides appropriate elevation accuracy and resolution for heron habitat suitability modeling (e.g., it is the dataset used by the Montana Natural Heritage Program in a 2022 publication of their Maxent Great Blue Heron HSI analysis). The DEIS explained that in >50% of years, there would be no pumping activity and thus the medians of base vs alternative differences are negligeable. From the DEIS, "The extent of flooded acreages is highly skewed by the relatively few years in which extensive backwater flooding above 90 ft occurred, making the mean much greater than the medians". Table C-1 shows mean and median values for base and alternative scenarios. Mitigation was calculated using means, as additional text in the DEIS states and the numbers in Table C-1 reflect. Thus, more mitigation was recommended than had we used medians, or even 75th percentiles. As described in the DEIS, the 75th percentile spatial layers were used in the baseline HSI model to represent areas where the most frequently flooded areas occur, means are highly skewed by outlying years of uncommon occurrence of extreme flood events. As such, the 75th percentile layer approximates an average of flooding conditions, among years in which flooded conditions above 90/93 ft pumping thresholds occur, under baseline conditions in which current heron populations exist. Figure C-3 is the Maxent response curve output, with the y-axis being a relative 0-1 index of predicted response for each variable and was included to highlight the most informative variables and values associated with increased habitat suitability indices (e.g., heron nesting suitability is greatest when close to shallow flooding, high-quality foraging habitat (modeled separately), and woody wetlands). Thank you for pointing out that we neglected to include units in the table caption (this Maxent output figure does not label axes), but distances were measured in ft and elevation is depicted in meters and this will be updated in the FEIS. Table C-6 is not missing site numbers; site 6 and site 7 were not modeled because there were no Great Blue Herons confirmed at the sites. This heron modeling effort was not used to assess shorebird impacts. Shorebird impacts were modeled separately.

Comment Number	Comment Date	Org.	Theme	Comment	Response
531	8/27/2024	NGO- National Audobon, National Wildlife Federation, Sierra club Audubon Delta, Healthy Gulf, Sierra Club MS	Alternatives	The DEIS Does Not Assess Cumulative Impacts The DEIS does not assess cumulative impacts, which is a fundamental failing as the cumulative impacts analysis is a critical component of NEPA review. The cumulative impact analysis ensures that the reviewing agency will not "treat the identified environmental concern in a vacuum."314 Cumulative effects are defined as: "effects on the environment that result from the incremental effects of the action when added to the effects of other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative effects can result from individually minor but collectively significant actions taking place over a period of time."315The cumulative impacts analysis must examine the cumulative effects of federal, state, and private projects and actions.316 The cumulative impacts analysis must also evaluate the cumulative impacts of climate change.317 Importantly, as the Council on Environmental Quality has made clear, in situations like those in the Yazoo Backwater Area where the environment has already been greatly modified by human activities, it is not sufficient to compare the impacts of the proposed alternative against the current conditions. Instead, the baseline must include a clear description of how the health of the resource has changed over time to determine whether additional stresses will push it over the edge.318 In evaluating cumulative impacts: "The analyst's primary goal is to determine the magnitude and significance of the environmental consequences of the proposed action in the context of the cumulative effects of other past, present, and future actions. Much of the environment has been greatly modified by human activities, and most resources, ecosystems, and human communities are in the process of change as a result of cumulative effects. The analyst must determine the realistic potential for the resource to sustain itself in the future and whether the proposed action will affect this potential; therefore, the baseline condition of the resource of concern should include a description of how conditions have changed over time and how they are likely to change in the future without the proposed action. The potential for a resource, ecosystem, and human community to sustain its structure and function depends on its resistance to stress and its ability to recover (i.e., its resilience). Determining whether the condition of the resource is within the range of natural variability or is vulnerable to rapid degradation is frequently problematic. Ideally, the analyst can identify a threshold beyond which change in the resource condition is detrimental. More often, the analyst must review the history of that resource and evaluate whether past degradation may place it near such a threshold. For example, the loss of 50% of historical wetlands within a watershed may indicate that further losses would significantly affect the capacity of the watershed to withstand floods. It is often the case that when a large proportion of a resource is lost, the system nears collapse as the surviving portion is pressed into service to perform more functions.A meaningful assessment of cumulative impacts must identify: "(1) the area in which effects of the proposed project will be felt; (2) the impacts that are expected in that area from the proposed project; (3) other actions – past, presen and proposed, and reasonably foreseeable – that have had or are expected to have impacts in the same area; (4) the impacts or expected impacts from these other action and (5) the overall impact that can be expected if the individual impacts are allowed to accumulate."320 In conducting the cumulative impacts assessment, it is not enough to simply catalog past, present, and reasonably foreseeable future actions. An EIS instead must determine the specific impacts on the system of those actions and determine whether those impacts combined with the proposed action would significantly affect the ecological health and functioning of the area impacted by the project. As recognized by the 2008 Clean Water Act Final Determination, the adverse impacts of the Yazoo Pumps must be considered: in the context of the significant cumulative losses across the Lower Mississippi River Alluvial Valley (LMRAV), which has already lost over 80 percent of its bottomland forested wetlands, and specifically in the Mississippi Delta where the proposed project would significantly degrade important bottomland forested wetlands.321 The majority of those losses have been traced directly to the effects of federal flood control and drainage projects.322 From just the 1970s to 2006, the Yazoo Backwater Area lost 11 percent of its remaining forested wetlands.323 The loss and/or degradation of many tens of thousands of additional acres of wetlands from the Yazoo Pumps Alternatives would have catastrophic implications for the ecology of the Lower Mississippi Alluvial Valley and for the fish and wildlife that rely on those resources. For some species, the Yazoo Pumps Alternatives could be the proverbial straw that breaks the camel's back pushing species to or past their tipping points. The DEIS also must comprehensively evaluate and account for the impacts to wetlands resulting from the highly significant reductions in flood stages in the project area. A discussed earlier in these comments, according to the 2020 FSEIS, there has been a 1 foot to 3 foot reduction in the 2-year floodplain elevation, which has resulted in the loss of at least 96,139 acres of wetlands in the 2-year floodplain in very short period of time. According to the 2020 Yazoo Pumps FSEIS, at least some of these significant reductions are the result of completion of the Holly Bluff Cut-off in 1958 and the Yazoo Backwater Levee in 1978:The median ≥5.0% flood duration elevation threshold was lowered approximately one to three feet as a result of implementation of the flood risk reduction features, translating to a large aerial decrease in potential wetland areas when superimposed on the Yazoo Study Area.324 The Notice of Intent for this DEIS states that the 2-year floodplain elevation is 1.7-feet-NGVD lower than provided in the 2007 EIS, and the 5-year floodplain elevation level is 2.6-feet-NGVD lower than provided in the 2007 FSEIS.325 The DEIS must fully evaluate the implications of these significant wetland losses throughout the Yazoo Backwater Area, the Mississippi Delta and the Mississippi River Alluvial Valley and the significant reductions if flood frequency elevations in the Yazoo Backwater Area. Notably, the EIS also must explain why, in the face of these significant changes in flood elevation, the authorized level of flood protection (as set forth in the 1941 project authorization) has not already been achieved. Additional information on this important issue is provided in Section S of these comments. The DEIS must then evaluate how these cumulative losses and alterations affect the wildlife species that rely on the Yazoo Backwater Area's wetlands and the Mississippi Delta and Mississippi River Alluvial Valley. The wildlife impacts must themselves be assessed in light of the significant losses of wildlife throughout these regions and beyond. A recent article in Science Magazine reported on the staggering loss of three billion north American birds since 1970: North America's birds are disappearing from the skies at a rate that's shocking even to ornithologists. Since the 1970s, the continent has lost 3 billion birds, nearly 30% of the total, and even common birds such as sparrows and blackbirds are in decline, U.S. and Canadian researchers report this week online in Science. "It's staggering," says first author Ken Rosenberg, a conservation scientist at the Cornell University Laboratory of Ornithology. The findings raise fears that some familiar species could go the way of the passenger pigeon, a species once so abundant that its extinction in the early 1900s seemed unthinkable. The results, from the most comprehensive inventory ever done of North American birds, point to ecosystems in disarray because of habitat loss and other factors that hav yet to be pinned down, researchers say.326 The EIS also must analyze the impacts of climate change in the cumulative impacts analysis. Indeed, analyzing the impacts of climate change is "precisely the kind of cumulative impacts analysis that NEPA requires agencies to conduct."327Climate change is already causing significant impacts in the Mississippi River Valley and these impacts will likely grow, as recognized by the recently released Fourth National Climate Assessment.328 The impacts of climate change are particularly significant for migratory species. As recognized by the United Nations Environment Program and the Convention on the Conservation of Migratory Species of Wild Animals, migratory wildlife is particularly vulnerable to the impacts of climate change: As a group, migratory wildlife appears to be particularly vulnerable to the impacts of Climate Change because it uses multiple habitats and sites and use a wide range of resources at different points of their migratory cycle. They are also subject to a wide range of physical conditions and often rely on predictable weather patterns, such as winds and ocean currents, which might change under the influence of Climate Change. Finally, they face a wide range of biological influences, such as predators, competitors and diseases that could be affected by Climate Change. While some of this is also true for more sedentary species, migrants have the potential to be affected by Climate Change not only on their breeding and non-breeding grounds but also while on migration. Apart from such direct impacts, factors that affect the migratory journey itself may affect other parts of a species' life cycle. Changes in the timing of migration may affect breeding or hibernation, for example if a species has to take longer than normal on migration, due to changes in conditions en route, then it may arrive late, obtain poorer quality breeding resources (such as territory) and be less productive as a result. If migration consumes more resources than normal, then individuals may have fewer resources to put into breeding . . . . * * * Key factors that are likely to affect all species, regardless of migratory tendency, are changes in prey distributions and changes or loss of habitat. Changes in prey may occur in terms of their distributions or in timing. The latter may occur though differential changes in developmental rates and can lead to a mismatch in timing between predators and prey ("phenological disjunction"). Changes in habitat quality (leading ultimately to habitat loss) may be important for migratory species that need a coherent network of sites to facilitate their migratory journeys. Habitat quality is especially important on staging or stop-over sites, as individuals need to consume large amounts of resource rapidly to continue their onward journey. Such high quality sites may [be] crucial to allow migrants to cross large ecological barriers, such as oceans or deserts.329Migratory birds are at particular risk from climate change. Migratory birds are affected by changes in water regime, mismatches with food supply, sea level rise, and habitat shifts, changes in prey range, and increased storm frequency.330 The DEIS must also carefully assess the cumulative impact on the loss of Yazoo Backwater Area wetlands in the context of the dire conditions currently facing amphibian populations worldwide and in the United States. Like migratory species, amphibians are at great risk from climate change. See discussion in Section H of these comments. Cumulative impacts must be fully assessed and fully accounted for in the DEIS.	Comment noted. A cumulative impact section has been added to the EIS for clarity.

Comment Number	Comment Date	Org.	Theme	Comment	Response
39,067-41,098	8/27/2024	Audubon Society	General Opposition	As someone who cares deeply about our country's birds, wildlife, and habitats, I am writing to express my strong opposition to the Corps' renewed effort to build the wasteful, ecologically devastating Yazoo Pumps. I urge the Corps to instead pursue a fully nature-based and nonstructural alternative in the Yazoo Backwater Area that can provide effective, environmentally sustainable flood relief for vulnerable communities and birds. These Mississippi Flyway wetlands are so valuable that the George W. Bush administration vetoed the Yazoo Pumps project in 2008 through the Clean Water Act to protect tens of thousands of acres of nationally important wetlands—a veto that the current administration reasserted. This rare veto explicitly bars the Corps' preferred alternative to build a 25,000 cubic-feet-per-second pumping plant, which will critically degrade the ecological functions of at least 90,000 acres of valuable wetland habitat. Yazoo backwater communities deserve commonsense flood relief through targeted nature-based and nonstructural solutions that can effectively get people and property out of harm's way, such as elevating homes and roads and compensating farmers to restore cropland to wetlands. Many local community leaders have asked for these 21st-century approaches that would benefit people and wildlife. I urge the Corps to abandon its misguided efforts to build the Yazoo Pumps and, instead work to advance a fully nature-based and nonstructural flood relief alternative that will protect local communities and hemispherically important wildlife habitat.	EPA implements CWA section 404(c) and issued the 2008 section 404(c) Final Determination concerning the Yazoo Backwater Area Pumps Project. USACE therefore cannot speak to the applicability of EPA's Final Determination. See response to comment 5.
41,099-42,097	8/27/2024	Audubon Society	General Opposition	Dear Army Colonel Jeremiah Gibson, I am writing to ask you to protect the vital wetlands in the Yazoo Backwater Area of Mississippi by recognizing the Environmental Protection Agency's long-standing Clean Water Act 404(c) veto protecting this area. The exceptional wetlands in the Backwater Area have been nurtured and restored by federal investment in USDA Farm Bill Programs on private land and through wetland and bottomland hardwood forest restoration projects on public lands: Delta National Forest, Federal Refuges and state wildlife management areas. Much of this work and investment by the USDA NRCS and private funders will be placed at risk from the U.S. Army Corps of Engineers' proposed Yazoo Backwater Pumping plant—an agricultural drainage project being promoted as flood control. The Corps' 24,000 cubic feet per second capacity pumping facility at Steele Bayou would be larger than any pumps anywhere in the Mississippi River drainage area. The preferred pumping schedule under Alternative 2 would start running the pumps as early as March 15th. There are serious concerns about the effect this would have on migratory birds and on floodplain dependent species of fish that spawn in floodplains during seasonal floods on coastal plain rivers like the Big Sunflower River in the backwater area. De-watering areas of the Yazoo Backwater Area through pumping also lowers water levels and removes late winter and early spring seasonal fish spawning habitat. River dependent fish species exit river channels during seasonal high water and use flooded backwater areas for spawning and rearing of juvenile fish. One of the strongest reasons that EPA gave for their veto of the Yazoo Pump Project in 2008 was to support fish spawning habitat. I urge you to support non-structural flood risk management methods in the Yazoo Backwater Area instead of pump construction. Nature-based and non-structural flood management should be employed here rather than a pump plan. One of the Corps' main stated purposes for creating a Yazoo Backwater Area flooding solution is to reduce agricultural intensification, but the plans to build pumps will support farmers' crop planting schedules, which only intensifies agriculture. The Corps is working with conflicting purposes. I ask that the Corps abandons the pump plans, and instead honors the 2008 Clean water act veto of the Yazoo Backwater Pumps.	EPA implements CWA section 404(c) and issued the 2008 section 404(c) Final Determination concerning the Yazoo Backwater Area Pumps Project. USACE therefore cannot speak to the applicability of EPA's Final Determination. See response to comment 5.
42,097-42,100	8/27/2024	Audubon Society	General Opposition	The Yazoo Pumps project would cost more than $1 billion and do little to protect communities from flooding. Eighty-three percent of the land that flooded during the 2019 flood event would still have been underwater if the Pumps had been in place. Not only would the proposal hurt the environment but the pumps would provide little flood protection for local communities and could worsen downstream flooding in marginalized Black communities. EPA's Clean Water Act veto of the Yazoo Pumps in 2008 was based on a rigorous analysis of potential impacts and broad public input, and was reasserted by the Biden administration. The veto was issued to permanently block construction of the ecologically destructive Yazoo Pumps—including this revived pumps proposal. I urgently ask the Army Corps to abandon this and any version of a pumps proposal, and instead ask the Army Corps, EPA, and Fish and Wildlife Service to pursue prompt and effective flood relief that prioritizes nature-based and non-structural measures to protect local communities while conserving vital wetlands that provide natural flood protection and climate resilience.	EPA implements CWA section 404(c) and issued the 2008 section 404(c) Final Determination concerning the Yazoo Backwater Area Pumps Project. USACE therefore cannot speak to the applicability of EPA's Final Determination. See response to comment 5.
42,101-43,000	8/27/2024	Sierra club	General Opposition	Dear Colonel Gipson, I am writing to express my strong opposition to the U.S. Army Corps of Engineers (Corps) renewed effort to build the environmentally devastating agricultural drainage project known as the Yazoo Backwater Pumps. I ask that you abandon the 2024 plan and eliminate all variations of the Yazoo Pumps once and for all. Instead, I urge the Corps to prioritize effective nature-based and nonstructural flood solutions that truly benefit vulnerable communities and wildlife. The Yazoo Pumps would be so harmful that the George W. Bush administration vetoed the project in 2008 through the Clean Water Act to protect tens of thousands of acres of nationally important wetlands. It is appalling that the Corps is now proposing a 78% larger Pump that would be the largest hydraulic pump in the world and would drain and damage 90,000 acres of wetlands. Contrary to the Corps? longstanding claim that the Pumps are the panacea to provide flood protection, your agency?s latest proposal would operate the Pumps based on agricultural planting seasons. This outrageous plan verifies past findings that the Pumps are not designed to protect communities from flooding; rather, 80% of the project benefits come from draining wetlands so agribusiness can make more money. Further, it?s disturbing that mandatory buyouts through condemnation of residential and commercial properties will be required--most of which are in disadvantaged rural communities. The plan also proposes voluntary buyouts for even more homes and businesses, as well as tens of thousands of acres of farmland. Communities plagued by flooding in the Mississippi Delta deserve 21st-century safeguards that keep people and property out of harm's way, such as elevating homes and roads and compensating farmers to restore cropland to wetlands. Many local community leaders have asked for these commonsense, nature-based, and nonstructural solutions to benefit people and wildlife. The Corps plan contains none of this. I urge the Corps to stop its misguided efforts to build this--or any--version of the Yazoo Pumps and, instead, work to advance proven, environmentally sustainable flood risk solutions that will protect local communities and globally important wildlife habitats.	EPA implements CWA section 404(c) and issued the 2008 section 404(c) Final Determination concerning the Yazoo Backwater Area Pumps Project. USACE therefore cannot speak to the applicability of EPA's Final Determination. See response to comment 5.
532-39,066	8/27/2024	Audubon Society	General Opposition	As someone who cares deeply about our country's birds, wildlife, and habitats, I am writing to express my strong opposition to the Corps' renewed effort to build the wasteful, ecologically devastating Yazoo Pumps. I urge the Corps to instead pursue a fully nature-based and nonstructural alternative in the Yazoo Backwater Area that can provide effective, environmentally sustainable flood relief for vulnerable communities and birds. These Mississippi Flyway wetlands are so valuable that the George W. Bush administration vetoed the Yazoo Pumps project in 2008 through the Clean Water Act to protect tens of thousands of acres of nationally important wetlands—a veto that the current administration reasserted. This rare veto explicitly bars the Corps' preferred alternative to build a 25,000 cubic-feet-per-second pumping plant, which will critically degrade the ecological functions of at least 90,000 acres of valuable wetland habitat. Yazoo backwater communities deserve commonsense flood relief through targeted nature-based and nonstructural solutions that can effectively get people and property out of harm's way, such as elevating homes and roads and compensating farmers to restore cropland to wetlands. Many local community leaders have asked for these 21st-century approaches that would benefit people and wildlife. I urge the Corps to abandon its misguided efforts to build the Yazoo Pumps and, instead work to advance a fully nature-based and nonstructural flood relief alternative that will protect local communities and hemispherically important wildlife habitat.	EPA implements CWA section 404(c) and issued the 2008 section 404(c) Final Determination concerning the Yazoo Backwater Area Pumps Project. USACE therefore cannot speak to the applicability of EPA's Final Determination. See response to comment 5.