Mississippi Valley Division,
Regional Planning and Environment Division South

Yazoo Backwater Area Water Management Project

APPENDIX C – Comments Received on the Final Environmental Impact Statement

January 2025

From: Jim.Poe
To: YazooBackwater MVK
Subject: [Non-DoD Source] Construction timeline
Date: Monday, December 16, 2024 16:00:10

Is there an update available on the potential timeline regarding the solicitation of this projects advertisement and bid dates.

Regards,

Jim Poe

Kiewit

2050 Roanoke Road, Suite 100
Westlake, TX 76262-9616
(817) 319-0104 cell
www.kiewit.com

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
ATLANTA, GA 30303

December 20, 2024

Colonel Jeremiah A. Gipson
District Engineer, Vicksburg District
U.S. Army Corps of Engineers
4155 East Clay Street
Vicksburg, MS 39183

Dear Colonel Gipson:

The U.S. Environmental Protection Agency (EPA) has reviewed the U.S. Army Corps of Engineers (USACE) final Environmental Impact Statement (EIS) for the Yazoo Backwater Area Water Management Project, which was published on November 29, 2024. The final EIS was reviewed in accordance with Section 102(2)(C) of the National Environmental Policy Act (NEPA) and Section 309 of the Clean Air Act (CAA). The CAA Section 309 role is unique to the EPA. Among other things, CAA Section 309 requires the EPA to review and comment on the environmental impacts of any proposed Federal action subject to NEPA's environmental impact statement requirements, and to 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 proposed project, and we appreciate the robust federal collaboration that occurred throughout the process. As detailed below, the EPA is attaching detailed technical comments that explain our remaining concerns and recommendations.

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 and May 4 and 5, 2023. The EPA provided scoping comments to the USACE on August 7, 2023, and comments on the draft EIS on August 27, 2024. The EPA also attended cooperating agency meetings beginning September 14, 2023, and public meetings on the draft EIS on July 22 and 23, 2024.

According to the final EIS, "The primary purpose of this Water Management Plan and FEIS is to reduce flood risk from flooding in the lower Mississippi Delta caused by excessive standing water for long periods of time." Additionally, the final EIS states, "The overall project purposes for the Yazoo Backwater Area Water Management Project are to provide a flood risk reduction solution for the Yazoo Study Area (YSA) communities and the local economy while avoiding and minimizing impacts to important environmental resources."

Four alternatives are evaluated in the final EIS. According to the USACE, Alternatives 1 (no action) and 4 (fully non-structural) did not meet the project purposes of providing effective flood risk reduction to the primary residences of the YSA and the infrastructure supporting those residences, or to maintaining the economic viability of the YSA. Alternatives 2 and 3 were fully evaluated in the final EIS and include the same structural and nonstructural components but differ in the dates of water level management. The structural components of Alternatives 2 and 3 include the construction and operation of a 25,000-cubic feet per second pump station, adjacent to the Steele Bayou water control structure. Alternative 3 is identified as the recommended Water Management Plan because it is the least environmentally damaging alternative. An important component of the Yazoo Backwater Area Water Management Project is the finalization of three memoranda of agreement between the Department of the Army, the USFWS, and the EPA on water control operations, mitigation, and monitoring data.

On August 27, 2024, the EPA submitted comments on the draft EIS regarding alternatives, aquatic resources, water quality, hydrologic and hydraulic analyses, water extent and duration analyses, environmental justice, air quality, costs and benefits, transportation, and the Clean Water Act Section 404(b)(1) evaluation. Based on the review of the final EIS, the EPA appreciates the USACE's efforts to address our previous comments. The EPA has some remaining concerns regarding hydrologic analyses, hydraulic analyses, water extent and duration analyses, and environmental justice that are recommended to be addressed in the record of decision. The remaining concerns and recommendations are detailed in the enclosure for your consideration. These recommendations are intended to help improve the environmental outcome of the proposed action and/or the transparency of the information used for decision making.

The EPA appreciates the opportunity to review and comment on the final EIS. If you have any questions, regarding our comments and recommendations, please contact Ntale Kajumba, NEPA Section Manager, at 404-562-9620 or at Kajumba.ntale@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: 2024.12.20 08:57:56 -05'00'

Jeaneanne M. Gettle
Acting Regional Administrator

Enclosure: Detailed Technical Comments

Enclosure

Detailed Technical Comments on the Final Environmental Impact Statement
for the Yazoo Backwater Area Water Management Plan
CEQ No: 20240224

Background

Flood risk reduction for the 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 YSA, including levees, associated drainage channels and water control structures. This infrastructure has significantly reduced the frequency and duration of flooding in the YSA from the Mississippi River. Despite implementation of these flood risk reduction features, backwater flooding in the YSA continues to occur during high Mississippi River events that result in the closure of the Steele Bayou water control structure, thereby causing water to accumulate behind the structure from rainfall that occurs within the YSA basin.

I. Alternatives

The USACE developed three action alternatives to address existing backwater flooding concerns in the YSA and the final EIS analyzes and compares the impacts associated with these alternatives. In addition to the three action alternatives, a no-action alternative was also considered. Alternative 3 is identified as the recommended Water Management Plan. Alternative 3 includes structural and nonstructural components.

- 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 gage during crop season (March 25 – October 15) and up to 93 feet NGVD29 during non-crop season (October 16 – March 24). Thirty-four supplemental low-flow groundwater wells would be installed.
- Nonstructural components: These actions would 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; voluntary acquisition of residential and commercial properties up to 90 feet (102 structures); voluntary floodproofing and/or acquisition of properties up to 93 feet (233 structures); and/or 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. Property owners that do not participate in an acquisition of structures could still be offered other nonstructural measures such as flood proofing or raising of structures.

This alternative has fewer estimated wetland functional losses (direct and indirect impacts) than Alternative 2. For example, estimated wetland functional losses of Alternatives 3 and 2 are 27,354 and 34,687 Average Annual Functional Capacity Units, respectively. Additionally, the estimated impacts on fisheries for each alternative are 2,184 and 1,748 Habitable Units (HUs) (Alternative 3 spawning and rearing) and 2,264 and 1,862 HUs (Alternative 2 spawning and rearing). Finally, when evaluating impacts to shorebirds, great blue heron, and wintering waterfowl, Alternative 3 was less damaging in all three cases.

Three Memoranda of Agreement (MOA) between the USACE, the USFWS, and the EPA were executed on November 25, 2024, to ensure continued collaboration on the Yazoo Backwater Area Water Management Project to ensure the Project is effectively implemented and aligns with each agency's authorities, missions, and values.

- The first MOA is an agreement on the final water control operations which provides that the USACE will obtain concurrence from the EPA prior to implementing any changes to or non-emergency deviations from the pump operation plan and water control structure operation plan described in the recommended alternative described in the final EIS.
- The second MOA is an agreement on procedures for the review, approval, and oversight of the compensatory mitigation for the recommended alternative. As part of this MOA, proposed work will not commence in waters of the United States until the USACE has obtained concurrence from the EPA on the mitigation plan for each compensatory mitigation component and all in-lieu fee program/mitigation bank credits have been purchased and/or USACE-constructed compensatory mitigation sites have been secured.
- Finally, the third MOA is an agreement on procedures for the development, review, approval, and oversight of long-term monitoring efforts designed to help identify actual project-induced, landscape-scale changes and thereby inform adaptive management decisions regarding ongoing implementation of water management and compensatory mitigation efforts in the YSA.

II. 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, which are explained in Appendix A (Engineering Report). The models were built using Hydrologic Engineering Center-Hydrologic Modeling System (HEC-HMS) and HEC-River Analysis System (HEC-RAS) frameworks to simulate past flooding events and impacts on stage water levels due to the future pump scenarios. Those stage water levels were then taken as input into the Flood Event Simulation Model (FESM), a geographic information system-based mapping tool used to convert stage water levels into flood extents and flood duration zones. Below we provide recommendations highlighting aspects of the USACE methodology that need to be addressed to ensure clarity and repeatability of the analyses, as they are the basis for the wildlife and wetland impact assessments.

<u>Recommendations:</u>

a) In addition to the visual comparisons of those calibration and validation years (Figures 2-58 through 2-75) which shows strongest agreement at the southern gages, perform appropriate numerical measures of goodness of fit (for example average difference in observed and modeled peak flows) for the 4 years of calibration and 4 years of validation data to bolster confidence in the model as it simulates historical and with-pump scenarios. Monthly goodness of fit measures was used for the original HEC-HMS models, yet the only numerical measure provided for HEC-RAS calibration and validation models is the peak flow comparison at Steele Bayou on Table 2-21.

b) Complete thorough flood extent and duration analysis prior to project construction and subsequent impacts to waters of the United States. Although much has been done to clarify FESM methods and assumptions within the final EIS, certain inputs, parameters, and validation steps are unclear, rendering the analysis unrepeatable by a third party. To address this concern, in our DEIS comment letter, the EPA recommended that the USACE use their existing and well-cited HEC-HMS models to produce flood extents and duration for years that approximate the 5-year floodplain. We understand that this process is more complex and takes several months to conduct a thorough analysis. To date, the agencies have discussed this matter at length, and those discussions have provided confidence that FESM extent outputs are similar to – and in some cases more conservative than – HEC-HMS and HEC-RAS outputs.

c) Include Figure 1-46 (Appendix A, page 96) within the ROD. This figure is not shown in the appendix.
d) Clarify in the ROD whether a 270-day or 360-day growing season was used in the analysis. Much of the text on pages 173-174, as well as Tables 2-37 and 2-38 of Appendix A is describing the mosaic file created for flood durations associated with 270 days of the growing season. It is our understanding, however, that a 360-day growing season was used for all analyses in this effort. This nuance is critically important to consider for the wetlands, fisheries, waterfowl, and terrestrial species impacts analyses.
e) Within the ROD, acknowledge instances of the mislabeling of alternatives that occurred within Appendix A of the final EIS. Alternatives 2 and 3 are mislabeled in certain portions of Appendix A, which makes it unclear which alternatives are being shown. Specifically, multiple locations in the text on page 175 and Table 2-37 mislabeled as Alternative 2 indicate a crop season start date of March 25.
f) Consider publicly releasing the referenced spreadsheets regarding the hydrologic and hydraulic analysis on the Yazoo website prior to issuance of the ROD. Appendix A makes several references to Excel spreadsheets (e.g., pages 158, 160, and 172) that were used as part of the analysis, but these do not appear to be available on the Yazoo website or linked within the final EIS. These referenced spreadsheets enable a more complete understanding of the hydrologic and hydraulic analysis of the EIS.

III. Environmental Justice

NEPA requires federal agencies to evaluate the reasonably foreseeable effects, including cumulative effects, of proposed actions significantly impacting the quality of the human environment, and such evaluation includes the proposed action's effects on communities with environmental justice concerns. Agencies should consider how such effects can be avoided, mitigated, or minimized, as appropriate.

The EPA appreciates the USACE's engagement of communities between the draft and the final EIS and the inclusion of additional information to enhance the environmental justice sections of the final EIS. Based on the final EIS, Section 5.1.1.1 includes information on the actions that the USACE and/or the non-federal sponsor will undertake in the public education campaign, prior to the Preconstruction Engineering and Design phase, to inform property owners. Section 6.3 of Appendix K also indicates that implementation of the Monitoring and Adaptive Management Plan (MAMP) will include, among other things, the development of mitigation measures based on community engagement and the formulation of metrics to track successful implementation of the mitigation measures.

Recommendations:

a) Continue to meaningfully engage affected communities, including those with environmental justice concerns, in the development of appropriate measures, milestones, and metrics as part of the implementation of the MAMP (Appendix K Section 6.3).
b) Include in the ROD a reference to section 102(2)(C) of NEPA (42 USC § 4332(2)(C)), in addition to the applicable executive orders, to adequately capture the relevant sources for the environmental justice analysis and the mitigation of impacts to areas with environmental justice concerns.

Lynn Fitch
ATTORNEY GENERAL

December 16, 2024

Mr. Mike Renacker
Senior Project Manager
U.S. Army Corps of Engineers, Vicksburg District
ATTN: CEMVK-PPMD
4155 East Clay Street, Room 248
Vicksburg, Mississippi 39183

Re: Yazoo Backwater Area Water Management Project
Final Environmental Impact Statement

Dear Mr. Renacker:

I commend the U.S. Army Corps of Engineers on the balanced solutions achieved by the Final Environmental Impact Statement ("FEIS") for the Yazoo Backwater Study Area. I am encouraged to see that the people of the Mississippi Delta, one of the most productive agricultural regions in the world, are one step closer to the Yazoo Backwater Pumps and relief from significant and recurring flooding. I appreciate the collaboration of the U.S. Army Corps of Engineers, the Environmental Protection Agency, the U.S. Fish and Wildlife Services, state partners, and our Congressional delegation in this effort to develop an implementable solution for the people of Mississippi.

The Mississippi Delta has so much to offer, from the naturally rich farmland and hardworking farmers that put food on the plates of the world to the wetlands running alongside one of the world's most vital waterways, providing a habitat for an abundant wildlife. We must make every effort to protect this unique natural treasure. Nearly one-fifth (17%) of Mississippi's workforce is employed by the agricultural sector, an $8.7 billion industry in our state, and the Mississippi Delta is in the top 10% of national production for catfish, rice, corn, and soybeans.

The continued flooding, especially the prolonged event in 2019, significantly threatens this agricultural industry and culture. The 2019 flooding lasted nearly 6 months and caused more than $800 million in damage. Even more, flooding like this threatens our safety and security when transportation networks, power grids, and other critical vital infrastructure are jeopardized due to constant flooding. This is particularly true for the low-income and underserved communities of the Delta, which make up approximately 80% of the affected area.

The FEIS proves mitigation that balances the needs of these residents, their homes, and their livelihoods against the protection of our natural resources through forested wetland restoration, soil management, and habitat restoration for fisheries and shorebirds is possible. I am especially pleased that this FEIS appears to be the result of strong community participation, with over 43,000 comments demonstrating that the voices of those most in need of being included in the solution were heard.

For more than 80 years, the people of the Mississippi Delta have awaited fulfillment of the government's promise to help them with this problem. Now that we stand at the brink of finally meeting this commitment, I stand with our Congressional delegation in asking that you promptly publish the Record of Decision and finish the Yazoo Backwater Pumps as soon as possible.

Thank you for the opportunity to share this public comment. Should you have questions or need any additional information from my office, please do not hesitate to contact me or Gregory Alston, Deputy for Policy of the Opinions and Policy Division of the Mississippi Attorney General's Office, at Gregory.Alston@ago.ms.gov.

Sincerely.

Lynn Fitch
Attorney General
State of Mississippi

From: Jessica Schlader
To: YazooBackwater MVK
Subject: [Non-DoD Source] Opposition to the Yazoo Pumps Project
Date: Friday, December 20, 2024 11:59:52
Attachments: image001.png

I am writing to express my strong opposition to the Yazoo Pumps project. The proposal not only threatens to destroy the irreplaceable wetlands of the Mississippi Delta but also perpetuates historical patterns of environmental injustice and racial inequity.

The wetlands slated for destruction serve as nature's "sponge," playing a critical role in flood mitigation, storm buffering, and biodiversity preservation. Eliminating this vital ecosystem would exacerbate environmental vulnerabilities for the region and harm the broader ecological health of the area.

Equally concerning, the proposed voluntary buyouts ignore the devastating social and historical implications for Black communities in the Delta. For generations, these families have overcome monumental barriers—including slavery, systemic racism, and economic discrimination—to achieve the dignity and stability of land ownership. To suggest relocation as a solution is to erase their heritage and dispossess them of their hard-won private property.

Historically, eminent domain and urban renewal policies have disproportionately targeted Black communities, displacing millions, and entrenching inequality. The Yazoo Pumps project risks continuing this legacy of injustice under the guise of flood management. For these communities, land ownership is not merely a material asset—it is a cornerstone of identity, resilience, and intergenerational wealth-building.

Destroying these wetlands and communities is both an environmental and moral failure. I urge the Corps to reconsider this harmful project and pursue equitable and sustainable alternatives that uphold environmental justice.

Sincerely,

Jessica Schlader **(she/her)**
Development Manager
National Mississippi River Museum & Aquarium
350 E. 3rd St., Dubuque, IA 52001
Office: 563-557-9545 x250
jschlader@rivermuseum.org
rivermuseum.org

Donate **Plan Your Visit**

Comments on the Final Environmental Impact Statement for the Yazoo Backwater Area Water Management Project, November 2024

Submitted by

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

December 30, 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 A: Letter to Bruno Pigott, Acting Assistant Administrator for Water from the Conservation Organizations, dated November 5, 2024.

Attachment B: Opperman, Jeffrey J., Ryan Luster, Bruce A. McKenney, Michael Roberts, and Amanda Wrona Meadows, 2010. Ecologically Functional Floodplains: Connectivity, Flow Regime, and Scale. Journal of the American Water Resources Association (JAWRA) 46(2):211-226 at 216, 218. DOI: 10.1111⁄j.1752-1688.2010.00426.x.

Attachment C: Schramm, Harold, Jr., Eggleton, Michael, 2006, Applicability of the Flood-Pulse Concept in a Temperate Floodplain River Ecosystem: Thermal and Temporal Components, River Res. Applic. 22: 543–553 (2006) (Doi: 10.1002/Rra.921).

Attachment D: Natural Resources Conservation Service Map of Easements in the Yazoo Backwater Area for FY2024

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) Final Environmental Impact Statement for the Yazoo Backwater Area Water Management Project dated November 2024 and released to the public on November 29, 2024 (the "FEIS").

The Conservation Organizations steadfastly oppose the Corps' Recommended Alternative (Alternative 3) which unquestionably violates the longstanding Clean Water Act veto of the Yazoo Pumps. We call on the Corps to reject this alternative and take all derivations of the destructive, ineffective, and costly Yazoo Pumps off the table once and for all.

Like every previous derivation of the Yazoo Pumps, Alternative 3 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[1]; 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 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[2]—solutions that have also been requested by many local community leaders, the U.S. Fish and Wildlife Service (USFWS), the U.S. Environmental Protection Agency (EPA), and many others. More than 175 conservation and social justice organizations, nearly 43,000 members of the public, and dozens of local community members have called on the Corps to abandon all variations of the Yazoo Pumps in favor of these effective 21st century flood solutions.

Detailed Comments

The FEIS fails to address or correct the many critical problems detailed in the more than 120 pages of detailed technical comments (plus attachments) submitted by the Conservation Organizations on the June 2024 Draft Environmental Impact Statement for the Yazoo Backwater Area Water Management Project (the DEIS). Accordingly, the Conservation Organizations' comments on the DEIS also apply fully to the FEIS and are incorporated by reference into these comments as though fully set forth herein.

Section A of these comments details why Alternative 3 is prohibited by the 2008 Clean Water Act veto. Sections B through J of these comments address the few responses in the FEIS to the Conservation Organizations' comments on the DEIS.

---

[1] 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.

[2] The Conservation Organizations have shared this Resilience Alternative with the Corps and other federal agencies on multiple occasions, including as Attachment A to the comments from the National Wildlife Federation, National Audubon Society, Sierra Club, Audubon Delta, Sierra Club Mississippi, and Healthy Gulf on the Corps of Engineers' June 2024 Draft Environmental Impact Statement for the Yazoo Backwater Area Water Management Project, submitted August 27, 2024 (hereafter, the "Conservation Organizations' comments on the DEIS").

A. The Recommended Alternative is Prohibited by the Clean Water Act Veto

Alternative 3 is prohibited by the 2008 Clean Water Act 404(c) veto of the Yazoo Pumps, as discussed at length in the Conservation Organizations' comments on the DEIS. As a result, Alternative 3 cannot be constructed. The Corps fails to address this fundamental issue in the FEIS.

Instead, the FEIS claims that the Corps "cannot speak to the applicability of EPA's Final Determination" because "EPA implements CWA section 404(c) and issued the 2008 section 404(c) Final Determination concerning the Yazoo Backwater Area Pumps Project."[3] This claim is unavailing. The Clean Water Act veto establishes clear legal prohibitions and limitations on actions related to the Yazoo Pumps that the Corps must comply with. The Corps may not avoid complying with these requirements because it does not implement section 404(c) just like a driver may not avoid complying with the speed limit because the driver did not establish the speed limit.

The Clean Water Act veto establishes two impacts-based prohibitions, as discussed at length in the Conservation Organizations' comments on the DEIS. Alternative 3 unquestionably violates both of these prohibitions causing far more harm to hundreds of species of fish and wildlife than acknowledged:

(1) The Clean Water Act veto prohibits functional impacts to more than 28,400 acres of wetlands in the Yazoo Backwater Area. Alternative 3 clearly violates this prohibition because it would damage the critical ecological functions of at least **89,628 acres of wetlands[4]**—an area of wetlands 3.2 times larger than the 28,400 acres of functional wetland impacts that trigger the veto, more than 9.6 times the wetland impacts of all other Clean Water Act vetoed projects combined, and twice as large as Washington D.C.[5]

(2) The Clean Water Act veto prohibits pumping below the 91-foot elevation to prevent unacceptable impacts "during the critical spawning and rearing months" of spring and summer.[6] Alternative 3 clearly violates this prohibition because its massive 25,000 cfs pumps would be turned on when levels **reach 89.5 feet[7]** during the critical spawning and rearing months—a level that is 1.5 feet **lower** than the pumping elevation allowed under the veto. Alternative 3 would be operated at this prohibited level from March 25 through October 15—seven critical months each year that include the spawning, rearing, spring migration, and fall migration seasons—to benefit industrial scale agriculture.

To prevent these unacceptable impacts, the Clean Water Act veto also prohibits the discharge of dredge and fill material for the purposes of constructing Alternative 3. The Clean Water Act veto prohibits the

---

[3] FEIS at 14; FEIS, Appendix B—Public Comments Corps, Responses to Comments 220, 222, 238, 239, 240, 241, 242, 339, 341, 347, 456, 457, 460, 484, 485, 491, 492, 493, 494, 495.

[4] Of these, 89,407 acres will be damaged by operation of Alternative 3 plus at least 221.37 acres that will be destroyed during construction. An additional 96.58 acres of other Waters of the U.S. will also be damaged or destroyed. FEIS, Appendix F-3—Wetlands at 21; FEIS, Appendix I—404(b)(1) Evaluation at 31.

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

[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 (hereafter, the Clean Water Act veto or 2008 Clean Water Act veto).

[7] FEIS at 40, Table 3-4.

discharge of dredge and fill material to construct a 14,000 cfs pumping plant and its related structures.[8] This prohibition clearly also prohibits the discharge of dredged or fill material for the purpose of constructing Alternative 3 (or Alternative 2) because the recommended 25,000 cfs pumping plant encompasses the prohibited 14,000 cfs pumps.[9]

Notably, the FEIS like the DEIS does not disclose the total number of wetland acres that will be impacted by construction and operation of Alternative 3.[10] To determine these total impacts—information critical to assessing Alternative 3—decision makers and the public must pull information from confusingly presented data spread across multiple pages in Appendix F-3, Updated Appendix F-3, and Appendix I:

- Appendix F-3 and Updated Appendix F-3, page 21
  "Under Alternative 2, a total of 236,913 acres (72%) of the 329,787 acres assessed as potential wetlands are not anticipated to undergo a change in flood inundation interval. Alternative 3 displays as similar results with 240,380 acres (73%) of the potential wetlands in the assessment area would not undergo a change in hydroperiod. The remaining acreage (~25% of the study area) is anticipated to exhibit a shift in flood inundation duration or frequency.[11]

- Updated Appendix F-3 Table 53, pages 71-72. As documented in footnote 12 of these comments, the total number of wetland acres that would be impacted by operating Alternative 3 was not included in the original version of Appendix F-3. While a corrected version was ultimately posted, the public was not notified of this posting.

- Appendix I, pages 9, 12, 13
  "The structural component consists of a 25,000-cubic-foot-per-second (cfs) pump managed to an elevation of 90.0 ft NGVD during crop season and up to an elevation of 93.0 ft NGVD during non-crop season at the Steele Bayou Pump Site. The construction of this structural feature shall include the pump station pads, inlet channel, outlet channel, a new levee access associated with the pump station, modified Hwy 465 realignment, and bridge to connect Hwy 465 over the outlet channel. This feature will also require the removal of part of the existing levee for construction of the inlet channel and subsequent construction of a bridge over the inlet channel. The pump station right of way (ROW) will be approximately 445 acres. The borrow material which is suitable for construction of these features will originate from excavation of the existing features of the Steele Bayou Pump site and from the onsite and offsite borrow areas. A

---

[8] 2008 Clean Water Act veto at iv; see, also 2007 FEIS, Appx. 6 at 6-89 (the proposed 14,000 cfs pumping plant required "an inlet channel, an outlet channel, a pump station with all appurtenant structures, and site work").

[9] FEIS, Appendix A—Engineering Summary at 250 ("The updated design is based on the previous pump station design at the Steele Bayou pump site that advanced to approximately 90% complete state.") and at 255 ("the major structures of the pump station will be largely unchanged from the previous design").

[10] We also note that as originally published, the FEIS Wetlands Appendix did not provide information on the total number of wetland acres that would be impacted by operation of Alternative 3. Specifically, as originally published the FEIS Wetland Appendix did not include a critical portion of DEIS Table 53 which provided the only accounting of total wetland acres damaged by operations in the entire 920-page DEIS. Compare the originally posted FEIS Appendix F3—Wetlands at Table 53 page 71 with DEIS Appendix F3—Wetlands Table 53 at pages 86-87. The Conservation Organizations appreciate that the Corps posted a corrected version of the FEIS Wetlands Appendix (that corrected version included the full version of DEIS Table 53). However, since the public was not notified about this update in any way, most members of the public are unlikely to know that the corrected version was posted.

[11] FEIS, Appendix F-3—Wetlands at 21.

comprehensive soil borings analysis shall be conducted prior to final design of the pump station and supporting features. If the analysis shows that the quantity and quality of borrow material found at the onsite Borrow Area does not meet the needs of the project features, additional material shall be collected from the offsite borrow area. The offsite Borrow Area is located on Highway 61, east of the Steele Bayou Pump site."[12]

"Total area impacted by presented project construction would be approximately 655 acres, of which 318 acres are considered wetlands or open waters. Project construction could also impact approximately 1,118 feet of potentially jurisdictional other waters which is identified in the preliminary jurisdictional determination made for the proposed borrow area."[13]

"According to preliminary plans, material taken from the channel and cofferdam excavation will be used to build the new levee, cofferdam, and structural backfill. If any of this material is deemed unsuitable for construction, fill will be collected from the onsite and offsite Borrow Areas. Up to 1,118 linear feet of Potentially Jurisdictional Other Waters located within the offsite borrow area could be altered during the construction process. Approximately 34.74 acres of TNW *Section 10* (Steele Bayou Channel & Yazoo River) will be temporarily impacted during the construction of the inlet and outlet channels to the Steele Bayou Pump Station. The existing inlet and outlet channels which have been preliminarily classified as Open Water *Section 10* will be dredged to establish the needed channel bottom depth which could impact up to 34.89 acres. Development of the pump site could also impose impacts to Open Water *Section 404*, Other Waters/(RPW) *Section 10/404*, and Other Waters/RPW *Section 404* accounting for a cumulative area of 26.95 acres. A maximum of 221.37 acres of wetlands will be filled during the construction of the presented Steele Bayou Pump Site."[14]

The Corps also did not disclose the total number of wetland acres that will be impacted by construction and operation of either of the Yazoo Pumps during the public meetings attended by members of the Conservation Organizations or in the project overview slides posted on the Corps' project website.

B. The FEIS Does Not Address the Many Problems with the DEIS Wetlands Analysis

The FEIS does not address or correct the many substantive problems with the wetlands impact analysis detailed in the Conservation Organizations' comments on the DEIS. Accordingly, the comments on the DEIS also apply fully to the FEIS and are incorporated by reference into these comments as though fully set forth herein.

The Conservation Organizations provide the following additional comments regarding the FEIS wetlands analysis.

(1) The HEC-RAS[15] model, model inputs, and model outputs provided by the Corps to the Conservation Organizations point to flaws in the Corps' modeling of wetland impacts.[16]

---

[12] FEIS, Appendix I—404(b)(1) Evaluation at 9.
[13] FEIS, Appendix I—404(b)(1) Evaluation at 12.
[14] FEIS, Appendix I—404(b)(1) Evaluation at 13.
[15] HEC-RAS stands for Hydraulic Engineering Center – River Analysis System. FEIS at 209.
[16] 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.

Notably, the provided HEC-RAS model inputs do not produce the HEC-RAS model outputs when run through the provided HEC-RAS model. The Conservation Organizations have no way to assess whether the input files or output files are incorrect or whether the problem lies in the model itself. This lack of replicability suggests that the model is not reliable and that the model outputs cannot be consistently trusted.

(2) The FEIS response to comment 508 states that the Corps did not rely on the 2013 HGM Regional Guidebook and that the Corps did not "determine the VFREQ" and "[t]hat variable is not used in the current assessment." Contrary to this assertion, however, the FEIS Wetland Appendix references use of and/or includes calculations for the VFREQ at pages 36, 39, 47, 51, 52, 53, 55, 57, 58, 60, 61, and 63.

Moreover, the fact that the Corps opted to not rely on the 2013 HGM Regional Guidebook should not affect the Corps' impact analysis as highlighted in the preference to the 2013 HGM Regional Guidebook. That preface makes clear that the 2013 Guidebook "consolidates" previously published guidebooks, including the 2002 Guidebook and that applying those earlier guidebooks "will yield essentially the same results as" the 2013 Guidebook:

> In 2002, the US Army Engineer Research and Development Center (ERDC) published *A Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing Wetland Functions of Selected Regional Wetland Subclasses, Yazoo Basin, Lower Mississippi River Alluvial Valley*, (Smith and Klimas 2002). This was followed in 2004 by *A Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing Wetland Functions of Forested Wetlands in the Delta Region of Arkansas, Lower Mississippi River Alluvial Valley* (Klimas et al. 2004, updated to Version 2.0 in 2011). This *Regional Guidebook* consolidates the two previously published guidebooks, and incorporates new sample data to extend coverage to all of the Mississippi Alluvial Valley (MAV) between the confluences of the Mississippi River with the Ohio River and the Red River. The current guidebook does not necessarily supersede those documents – users familiar with those earlier reports can continue to apply them within their regions of applicability if they prefer, and they will yield essentially the same results as this guidebook. However, this version is designed to be applied more quickly; it requires less data collection and provides simplified data input forms. This guidebook can also be used in parts of the MAV not covered by the previous guidebooks.[17]

(3) The FEIS response to comment 508 contends that the 2013 HGM Regional 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 . . . ." This response does not refute (or even address) the point at issue: that the Corps failed to utilize the appropriate period of record for determining flood frequency and wetland classifications, as documented in the Conservation Organizations' comments on the DEIS:

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.

[17] 2013 HGM Regional Guidebook at vii.

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):

> 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.[18]

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**.

(4) The FEIS response to comment 508 states that "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." This response confirms rather than refutes the Conservation Organizations' comment that the Corps' reliance on new flood frequency elevations has resulted in fewer acres being categorized as "riverine wetlands" which in turn results in a showing of fewer wetland impacts from Alternative 3.

The 2008 Clean Water Act veto concludes that the Corps' 2007 FEIS failed to assess 52,000 acres of wetlands within the 2-year floodplain, including at least 24,000 acres of wetlands connected to backwater flooding:

> As discussed in Appendix 5, EPA's Environmental Monitoring and Assessment Program (EMAP) analysis identified approximately 52,000 acres of wetlands which are located on the 2-year floodplain but outside of the wetland assessment area established in the FSEIS (Figure 5). EPA believes that as much as 24,000 acres of these 52,000 acres of wetlands are connected to backwater flooding and will be adversely impacted by the project to an even greater degree than the wetlands considered in the FSEIS. However, the FSEIS did not evaluate impacts to these wetlands. Therefore the following section also includes a discussion of the scope and nature of the adverse impacts to these 24,000 acres of wetlands.[19]

[18] 2013 HGM Regional Guidebook at 61.
[19] 2008 Clean Water Act veto at 45, 47.

As a result, even if the Corps did assess 2430 more acres of wetlands in the 2-year floodplain than the Corps assessed in the 2007 study, the FEIS still did not assess 49,570 acres of wetlands that were known to exist in the 2-year floodplain in 2007.

C. The FEIS Does Not Address the Many Problems with the DEIS Fisheries Analysis

Data provided by the Corps after the close of the public comment period on the DEIS demonstrates another fundamental flaw in the FEIS analysis of impacts to the rich fishery resources that rely on the Yazoo Backwater Area. This data and its implications are discussed in Section C.1 below.

The FEIS fails to address or correct the many substantive problems with the fisheries analysis detailed in the Conservation Organizations' comments on the DEIS. Accordingly, the comments on the DEIS also apply fully to the FEIS and are incorporated by reference into these comments as though fully set forth herein. The few general responses provided by the Corps to the Conservation Organizations' detailed comments on the DEIS fisheries impacts analysis are discussed in Section C.2 below.

1. Data Provided After the DEIS Public Comment Period Reveals Additional Significant Flaws in the EnviroFish Analysis

After the close of the public comment period on the DEIS, the Conservation Organizations received documents from the Corps in response to a Freedom of Information Act (FOIA) request for "all documents" demonstrating the input data used to parameterize the EnviroFish model and the output data from that model.[20] Most critically, the provided documents show that the **EnviroFish model failed to assess fisheries impacts above the 1-year floodplain and failed to assess all fisheries impacts within the 1-year floodplain.** This adds to the many other failings with the EnviroFish analysis documented in the Conservation Organizations' comments on the DEIS.

The Conservation Organizations promptly highlighted these significant problems in a November 5, 2024 letter shared with the Corps before the agency released the FEIS.[21] While the FEIS does not address the critical points raised in our letter, the Corps did provide a partial response in a letter dated December 10, 2024 (the "December 10 Letter).[22] Critically, the Corps' December 10 Letter confirms the

[20] These documents were provided by the Corps' Engineer Research and Development Center on October 27, 2024, in response to a Freedom of Information Act request submitted on June 28, 2024. This FOIA requested additional information as well, and the Corps provided additional documents in response. A copy of the documents related to the Corps' EnviroFish analysis can be accessed at https://waterprotectionnetwork.org/wp-content/uploads/2024/11/EnviroFish_Calculations-August-2024.xlsx.

[21] Letter to Bruno Pigott, Acting Assistant Administrator for Water from the Conservation Organizations, dated November 5, 2024. Copies of this letter were also delivered to Jaime Pinkham, Acting Assistant Secretary of the Army (Civil Works), Robyn Colosimo, Deputy Assistant Secretary of the Army (Project Planning and Review), YazooBackwater@usace.army.mil,and Daffny Pitchford, U.S. Fish and Wildlife Service, Deputy Regional Director Southeast Region. A copy of this letter is provided at Attachment A to these comments.

[22] December 10, 2024, Letter from Jamie Pinkham, Acting Assistant Secretary of the Army for Civil Works to Melissa Samet, Legal Director Water Resources and Coasts for the National Wildlife Federation. This letter was delivered to Conservation Organizations via email on December 13, 2024 (14 days after the start of the 30-day public review period on the FEIS).

fundamental problem that taints the EnviroFish model and related analyses in the DEIS—the EnviroFish model relied on a "mean" elevation level below the 1-year floodplain.[23]

As the Corps is aware, the EnviroFish model was used to identify the maximum, minimum, and mean habitat elevations for fish breeding and rearing in the Yazoo Backwater Area. The EnviroFish model and FEIS then relied on the mean elevation as the baseline for assessing the Yazoo Pumps' impacts to fish, shorebirds, and wading birds.

According to the Corps' December 10 Letter, the mean stage used for assessing fisheries impacts was below the 1-year elevation:

> During the period of record there were 5246 days within the spawning season (122 days/year * 43 years = 5246). Of those days only 1221 days (23.3%) were greater than the 1-year (partial frequency) elevation, which means 76.7% were less than the 1-year elevation. **Therefore, the mean stage during the fishery season will be less than the 1-year elevation**.[24]

Critically, however, the elevations used in the EnviroFish model are not representative of the actual conditions that will exist in the Yazoo Backwater Area when the Yazoo Pumps are used.

For example, the EnviroFish model shows the maximum elevation during the spawning and rearing season as 87.91 feet at Steele Bayou (landside).[25] This elevation is **below** the 2-year and 5-year floodplain elevations,[26] which provide habitat for spawning and rearing as stated in the FEIS and the Corps' HGM Regional Guidebook.[27] However, the Corps' own RiverGages data documents that actual water elevations exceeded—and often greatly exceeded—87.91 feet during the breeding and rearing season during **28 years** over the period of record[28], as depicted in Figure 1.

---

[23] The Corps' December 10 Letter also provides a clarification regarding the data that was used to parameterize the EnviroFish model, and the Conservation Organizations appreciate this clarification. We note, however, that the supporting documents referenced by the Corps in that letter (EnviroFish-Sept2023_SAS and SB_EnviroFish_NWF) were not provided to the Conservation Organizations until December 18, 2024. Contrary to the suggestion in the December 10 Letter, these documents were not provided with the December 10 Letter, were not provided in response to our original FOIA for the EnviroFish input and output data, were not provided in the FEIS, and were not provided in the DEIS.
[24] December 10 Letter (emphasis added).
[25] USACE EnviroFish Calculations August 2024 at Summary Tab.
[26] FEIS, Appendix A, Engineering Report.
[27] 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).
[28] Data obtained from the USACE RiverGages.com website.

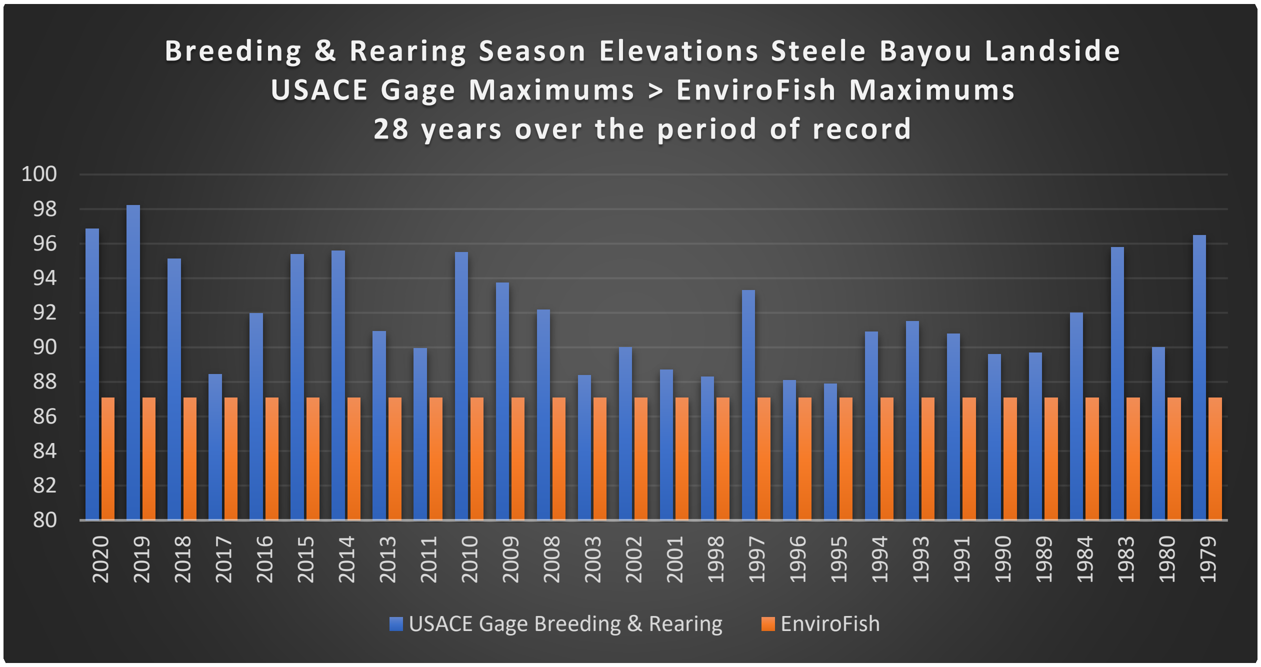


Figure 1: Breeding & Rearing Season Elevations at Steele Bayou, USACE Gage Maximums vs EnviroFish Maximums

The Corps then compounds the problems created by its already significant underestimates of maximum habitat elevations by relying on the much lower average (mean) of the maximum and minimum elevations as the baseline for assessing the Yazoo Pumps' impacts to fish, shorebirds, and wading birds. According to the EnviroFish model outputs, the mean elevation for spawning and rearing habitat at Steele Bayou (landside gage) is 81 feet.[29] This is **8.3 to 9.6 feet <u>below</u> the elevation of the 2-year floodplain**, depending on the "series" used by the Corps.

Indeed, the EnviroFish mean elevation is **below** the 1-year floodplain at all gage stations, as established by the "Partial Series" which the FEIS has used to assess the amount of fisheries mitigation[30], as shown in Figure 2 below. This is also confirmed in the Corps' December 10 Letter.

[29] USACE EnviroFish Output Data at Summary Tab (EnviroFish Summary by Season and Gage - 2023 Study).
[30] FEIS, Appendix A, Engineering Report at 136 and Table 1-23 at 136-137.

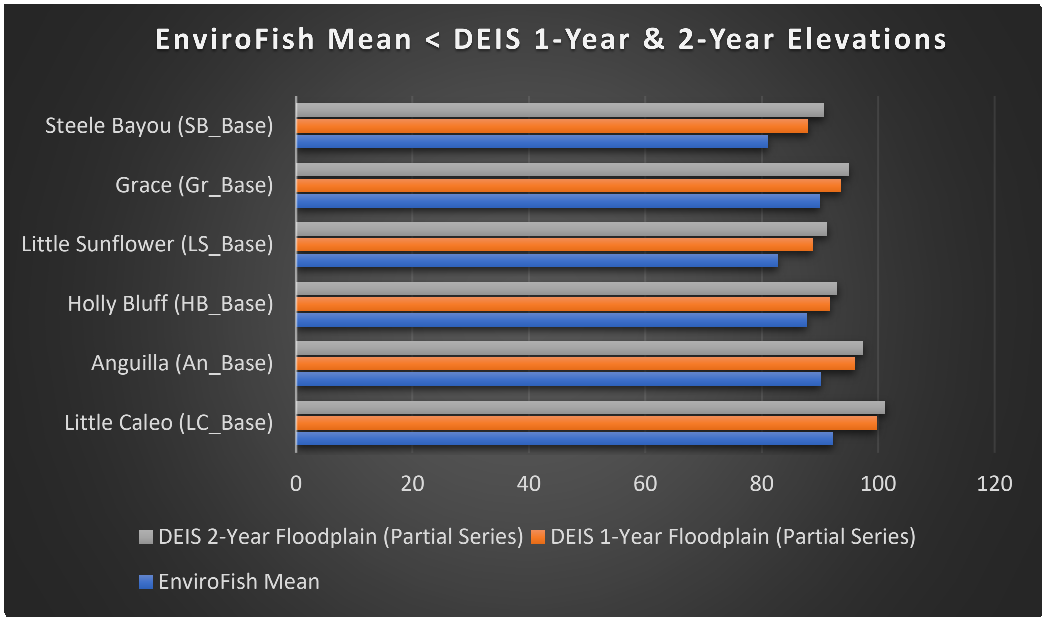


Figure 2: EnviroFish Mean Elevations vs. DEIS 1-Year & 2-Year Floodplain Elevations (Partial Series)

In short, the EnviroFish model did not look for—and as a result, did not "see" or account for—impacts above 81 feet. Instead, the EnviroFish model looked only at impacts to spawning and rearing habitat that occur below 81 feet.

These problems are created by determining maximum, minimum, and mean elevations based on the entire period of record instead of assessing those elevations based on water levels that existed during the years when the pumps would have been operating, and by relying on averages of averages that further masks impacts.[31] These problems are then further compounded by failing to assess and account for the loss of 14 consecutive days of overbank flooding as directed by the Clean Water Act veto.[32]

As a result, the EnviroFish model does not assess the actual impacts to fisheries that will occur from operating the Yazoo Pumps when water levels reach the 89.5-foot elevation during the critical spawning and rearing months. This means that the FEIS fisheries analysis does not assess the actual impacts from the Alternative 3 operating plan[33], which is designed to keep water from exceeding the 90-foot elevation from March 25 through October 15—a period that includes the critical spawning and rearing months for at least 58 different species of floodplain fish that rely on the Yazoo Backwater Area wetlands.

The flawed outputs from the EnviroFish model also taint the FEIS analysis of shorebird and wading bird impacts because the EnviroFish model outputs formed the foundation of the shorebird and wading bird models.[34] The mean elevations produced by the EnviroFish model do not align with the water

---

[31] Conservation Organizations' comments on the DEIS at 53-60.

[32] 2008 Clean Water Act veto, Fisheries Technical Appendix at 17.

[33] This also means that the FEIS fisheries analysis ignores the fundamental purpose of the Yazoo Pumps, which is to keep water levels from exceeding certain elevations during certain flood events. Instead, the fisheries analysis pretends that those floods will never happen.

[34] FEIS, Appendix F-4 at 5 ("This is the first study the CEMVK has been involved with for GBHE and shorebirds, and no models have been established to perform these analyses. However, CEMVK believes that the EnviroFish model provides the necessary outputs for these analyses. The EnviroFish model calculates four daily statistics, which are

elevations that will exist when the Yazoo Pumps would be operating, and as such cannot properly be used to assess impacts to shorebird and wading birds. The shorebird and wading bird impact assessments also suffer from many other highly significant flaws, as extensively documented in the Conservation Organizations' Comments on the DEIS.[35]

2. The FEIS Does Not Address the Many Problems with the Fisheries Impacts Analysis Detailed in the Conservation Organizations' Comments on the DEIS

The FEIS fails to address or correct the many substantive problems with the fisheries analysis detailed in the Conservation Organizations' comments on the DEIS. Accordingly, the comments on the DEIS also apply fully to the FEIS and are incorporated by reference into these comments as though fully set forth herein. The few general responses provided by the Corps to our detailed comments on the DEIS fisheries analysis are discussed below.

FEIS Response to Comment 462: In response to our comments on the DEIS fisheries analysis, the FEIS states: "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."

While we appreciate the Corps' engagement with other federal agencies, the Corps is the lead agency for this project and is responsible for ensuring full compliance with applicable laws and policies, including the prohibitions and conditions established by the Clean Water Act veto. As highlighted in our DEIS comments, the Clean Water Act veto explicitly rejected use of an "8 consecutive days at 1 foot" spawning criteria because it significantly underestimates adverse impacts. As documented in the veto:

> 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.[36]
>
> 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."[37]

---

water depth (water surface elevation), total rearing area, restricted rearing area, and spawning area. The restricted rearing bin of the EnviroFish model allows the user to establish minimum and maximum water depths.").
[35] Conservation Organizations' comments on the DEIS at 43-48.
[36] 2008 Clean Water Act veto, Fisheries Technical Appendix at 17.
[37] 2008 Clean Water Act veto at 56.

> Many fish species also rely on the floodplain to provide rearing habitat.[38] 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.[39]

The "8 consecutive day" criterion relied upon by the Corps is at best, the minimum amount of time needed for successful egg hatching. Critically however, “8 consecutive days” may not even be sufficient for egg hatching as stated in the Clean Water Act veto. In short, **while 8 days may be long enough for egg hatching in some years, it may not be long enough in all years.[40]**

Use of an “8 consecutive day” criterion also provides no buffer at all for successful spawning. Instead, it assumes that fish spawning can be turned on and off with the flick of a switch like a machine. Biological systems are far more complex and subject to multiple factors that must align before fish can spawn. For example, egg development and hatching are temperature-dependent, and eggs will develop and hatch more quickly during warm temperatures and more slowly during cooler temperatures.

As noted above, the FEIS contends that the EnviroFish model considered “the full range of early life stages” because “EnviroFish also considers rearing habitat that does not have hydraulic or day-duration restrictions.”[41] While we appreciate the consideration of impacts to rearing habitat (which is essential for understanding fisheries impacts), impacts to rearing habitat cannot properly be divorced from impacts to spawning. Newly hatched fish require immediate access to rearing habitat, making analysis of an appropriate number of consecutive days of inundation a critical component of any fisheries impacts analysis.

Indeed, the loss of the necessary consecutive days of overbank flooding will have significant impacts to survival as documented in the Clean Water Act veto:

> Utilizing literature and discussions with fishery biologists, eight consecutive days of flooding is a minimum length of time to successfully spawn. Larval fry are extremely vulnerable for the first 7 to 10 days, particularly to predation. If those fry are forced, by loss of flooded habitat, into deeper channels prior to 21 to 30 days of growth, a fish spawn may be successful, but survival rates of the fry are minimal. So, the spawn may be successful, but the recruitment of young to adult is very low.[42]

* * *

[38] 2008 Clean Water Act veto at 34.
[39] 2008 Clean Water Act veto at 56.
[40] Contrary to the Corps’ contention, use of an 8 consecutive day criterion does not provide a conservative estimate of impacts, but instead significantly underestimates fisheries impacts, as recognized by the Clean Water Act veto, the U.S. Fish and Wildlife Service, and the scientific literature.
[41] FEIS Response to Comment 462.
[42] 2008 Clean Water Act veto, Appendix 1 Clean Water Act Section 404(c) Review of Yazoo Backwater Area Pumps Project Response to Comments at 60.

> Eight days is the minimum needed to successfully spawn. Larval fish require 21 to 30 days of growth for a reasonable chance of survival. Thus, successful fish reproduction requires habitat flooded for at least 21 days.[43]

The scientific literature also shows that floods of longer durations provide important benefits to floodplain fish that are not provided by floods of shorter duration (i.e., a flood that only persists for 8 consecutive days). For example, one study determined that "floodplain productivity is much greater when long-duration flooding occurs during periods of warmer temperatures and abundant sunshine" and that a "floodplain that rarely is inundated by a floodplain activation flood will not produce the ecological benefits of food-web productivity or spawning and rearing habitat for native fish."[44] Another study found that the "growth increment" for blue catfish "was consistently greater across year classes during GY 1996 (CY 1995), a year of protracted warm-water floodplain inundation."[45] The FEIS does not assess the impacts to fisheries from the project-induced losses of longer-duration floods.

FEIS Response to Comment 463: In response to our comments on the DEIS fisheries analysis, the FEIS provides responses that are not supported by information in the FEIS and/or that are directly contradicted in the EIS. These include the following:

(1) The FEIS response to comment 463 states that "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."

While we appreciate this clarification and related correction in the FEIS, as discussed above the EnviroFish model bases its impacts analysis on a flawed assessment of, and an inappropriate reliance on, the mean elevation of spawning and rearing habitats. Based on the mean habitat levels used by the model, the DEIS only assessed fisheries impacts to a subset of habitat within the 1-year floodplain, as discussed above.

As highlighted in our comments on the DEIS, failing to assess the full array of impacts at least throughout the 5-year floodplain is extremely problematic. Among many other problems, this failure means that the FEIS has not assessed the impacts from the loss of **all** spawning and rearing habitat above the 2-year floodplain that will result from operation of the Yazoo Pumps. Indeed, the fundamental purpose of the pumps is to prevent water levels from rising above the 2-year floodplain throughout the crop season—a period that includes the entire spawning and rearing season. This failure also means that the Corps has not assessed the full array of impacts from the loss of spawning and rearing habitat within the 1-year floodplain.

---

[43] 2008 Clean Water Act veto, Appendix 1 at 67.

[44] Opperman, Jeffrey J., Ryan Luster, Bruce A. McKenney, Michael Roberts, and Amanda Wrona Meadows, 2010. Ecologically Functional Floodplains: Connectivity, Flow Regime, and Scale. Journal of the American Water Resources Association (JAWRA) 46(2):211-226 at 216, 218. DOI: 10.1111⁄j.1752-1688.2010.00426.x. A copy of this study is provided at Attachment B.

[45] Schramm, Harold, Jr., Eggleton, Michael, 2006, Applicability of the Flood-Pulse Concept in a Temperate Floodplain River Ecosystem: Thermal and Temporal Components, River Res. Applic. 22: 543–553 (2006) (Doi: 10.1002/Rra.921). A copy of this study is provided at Attachment C.

(2) The FEIS response to comment 463 states that "Wetland mitigation requirements were higher than aquatic impacts, so mitigating for wetlands will fully compensate for aquatics, even beyond the Envirofish calculations."

According to the FEIS, the proposed mitigation for the damage to almost 90,000 acres of wetlands:

> involves acquiring and reforesting **up to 5,722 acres** of frequently flooded agricultural land as well as creating approximately 403 acres of moist soil units to mitigate for anticipated shorebird impacts. A multifaceted approach to mitigation planning will achieve the overall mitigation goals through the use of an existing in lieu fee program; USACE constructed mitigation sites; and/or the use of existing mitigation banks.[46]

Notably, the FEIS itself does not commit the Corps to implementing this unacceptably small amount of mitigation as the FEIS explicitly states that the Corps recommends acquisition and reforestation of "up to 5,722 acres."

As discussed at length in our DEIS comments, this approach to mitigation cannot and does not ensure replacement of, or offsets to, "damages to ecological resources, including terrestrial and aquatic resources, and fish and wildlife losses" as required by law.[47] To the contrary, this approach allows predicted gains in some functions to count as mitigation for the loss of other critical functions that may not be replaced. However, as the USFWS made clear, "[t]he total mitigation required to compensate aquatic and terrestrial habitat is *not* additive."[48] The mitigation proposed in the FEIS also suffers from many, if not all, of the same problems identified in the Clean Water Act veto.[49]

Critically, for example, the acquisition and reforestation of frequently flooded agricultural lands does not ensure mitigation for the loss and reduction in the extent of overbank flooding that is critical for fish spawning and rearing. This is exemplified by the success criteria in the Ducks Unlimited In-Lieu Fee program that is anticipated to be able to provide the full amount of fisheries and aquatic resources mitigation,[50] and which the FEIS identifies as the primary tool for mitigation.[51]

---

[46] FEIS at v (emphasis added).
[47] 33 U.S.C. § 2283(d).
[48] FEIS Appx. D-2 at 13.
[49] See, e.g., Clean Water Act, Appendix 1 at 23, 32, 34, 57-58.
[50] Compare Draft Instrument Amendment to add the Yazoo Backwater Preserve Project to the Ducks Unlimited Mississippi Delta In-Lieu Fee Program Prepared by Ducks Unlimited (5 November 2024) at 28 (the sites are expected to provide fisheries offsets of at least 3,851 ADFAs) with FEIS at 82, Table 182 (identifying needed fisheries mitigation of 3,851 ADFAs).
[51] FEIS at 179 ("Compensatory mitigation is proposed to be provided through utilization of an in-lieu fee (ILF) program servicing the project area and would consist of bottomland hardwood reforestation of frequently flooded agricultural land, aquatic and shorebird reforestation. The only ILF program which services the project area is the Ducks Unlimited Mississippi Delta Program (project number MVK-2009-198)."); FEIS Appendix J—Compensatory Mitigation Plan at 43 ("The recommended plan for compensatory mitigation in the Yazoo Backwater Management Plan is to persue [sic] a plan with Duck's Unlimited In-Lieu Fee program. The plan presented throughout this document is a backup plan in case the In-Lieu Fee program is not successful (not meeting or exceeding USACE standards).").

The proposed Ducks Unlimited In-Lieu Fee program instrument states:

> The Success Criteria will follow those outlined in the Vicksburg as outlined below:
> **Wetland:**
> • **Wetland Hydrology.** The hydrology monitoring should display wetland hydrology which is defined as whether the site is inundated (flooded or ponded) **or the water table is ≤12 inches below the soil surface for ≥14 consecutive days during the growing season at a minimum frequency of 5 years in 10 (≥50% probability**) (ERDC TN-WRAP-05-2). **Any combination of inundation or shallow water table is acceptable in meeting the 14-day minimum requirement**. Short-term monitoring data may be used to address the frequency requirement if the normality of rainfall occurring prior to and during the monitoring period each year is considered. A site must be inundated or saturated typical of a reference condition for the same HGM hydrology classification. A site must meet wetland hydrology criteria as described in the USACE Wetland Delineation Method, 1987 Manual /or Atlantic/Gulf Coast Regional Supplement.[52]

These wetland hydrology criteria do not ensure effective mitigation for floodplain spawning and rearing habitat, including because floodplain dependent fish cannot spawn or rear in wet soil regardless of when, for how long, or how often the soil is wet.

D. The FEIS Does Not Address the Many Problems with the DEIS Native Bird Analyses

The FEIS fails to address or correct the many substantive problems with the analyses of impacts to native birds detailed in the Conservation Organizations' comments on the DEIS. The FEIS makes no substantive changes to the models or interpretations of model outputs to the native bird analyses in Appendix F-4 and Appendix F-5. Accordingly, the comments on the DEIS also apply fully to the FEIS and are incorporated by reference into these comments as though fully set forth herein. The few responses provided by the Corps to our detailed comments on the DEIS native bird impacts analysis are discussed below.

<u>FEIS Response to Comment 521</u>: In response to our comments on the DEIS marsh bird analysis, the FEIS provides responses that are not supported by information in the FEIS and/or that are directly contradicted in the FEIS. These include the following:

(1) The FEIS response to comment 521 states that the FEIS used the "most conservative" approach for assessing marsh bird impacts, including through the following statements:

> most conservative approach for delineating land cover types that may be suitable for marsh birds . . . over-estimating areas that may not be used by all species but results in the highest impact being considered . . . . Again, this takes the more conservative

---

[52] Draft Instrument Amendment to add the Yazoo Backwater Preserve Project to the Ducks Unlimited Mississippi Delta In-Lieu Fee Program Prepared by Ducks Unlimited (5 November 2024) at 39. A copy of this Draft Instrument Amendment is in the possession of the Corps and can be accessed at www.mvk.usace.army.mil/Portals/58/docs/regulatory/publicnotices/Draft%20Amendment%20to%20add%20Yazoo%20Backwater%20Preserve%20to%20MSD%20ILF_2024.11.05.pdf?ver=Ec_JfhfXlFI5YlNkLiP6sw%3d%3d. We request that the Corps include this Draft Instrument in the record for the FEIS.

> 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.

These statements are incorrect. Instead of taking a "conservative approach," the FEIS takes an approach that dilutes the ability to detect acres lost by including a very large range of water depths.

(2) The FEIS response to comment 521 states that “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 . . .” If this is in fact the case, the FEIS write-up of the model is incorrect. For example, the FEIS model write-up states: “From the hydrology information provided by MVK (75% percentile flood inundation), we were able to identify areas flooded to 0-18 inches (useable water depth) and 0-8.4 inches (ideal water depth) under the no action and alternative scenarios.”[53]

<u>FEIS Response to Comment 522</u>: In response to our comments on the DEIS analysis of migratory landbird impacts, the FEIS provides a number of responses that are not supported by information provided in the FEIS and/or that are directly contradicted in the EIS. These include the following:

(1) The FEIS response to comment 522 contends that “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.” The FEIS makes clear, however, that areas below the 90-foot elevation will in fact be affected by operation of the Yazoo Pumps, including through changes to the extent and duration of inundation from overbank flooding.[54]

Indeed, by definition, elevations **<u>below</u>** the 90-foot level will be impacted because the pumps will be turned on when water levels reach the 89.5-foot elevation during the defined 7-month crop season. Alternative 3 will also cause ecological harm below the 90-foot elevation as acknowledged in the FEIS.[55] For example, the FEIS found significant adverse impacts to fish spawning and rearing habitats even though it only looked at the impacts that would occur below the 81-foot elevation, as discussed in Section C of these comments. According to the FEIS, Alternative 3 would result in the loss of 2,184 habitat units for spawning and 1,747 habitat units for rearing.[56] According to the FEIS, offsetting these impacts will require 3,088 acres of mitigation.[57]

Of course, elevations **<u>above</u>** the 90-foot level will also be affected by Alternative 3, which is intended to prevent water levels from ever exceeding the 90-foot elevation during those times

[53] FEIS, Appendix F-4—Terrestrial Wildlife (Marsh Birds, Appendix D) at 91.
[54] See., e.g., FEIS, Appendix F-3—Wetlands.
[55] See, e.g., FEIS, Appendix F-6—Aquatic Resources and Fisheries at 12, Table 1.
[56] FEIS, Appendix F-6—Aquatic Resources and Fisheries at 11.
[57] FEIS, Appendix F-6—Aquatic Resources and Fisheries at 11.

of the year when flooding is most prevalent in the Yazoo Backwater Area. In addition, impacts below the 90-foot elevation will also result in impacts above the 90-foot elevation due to the fact that flooding to the 90-foot elevation affects soil moisture, water tables, and other critical parameters about the 90-foot elevation.

(2) The FEIS response to comment 522 states that "the only year in which the pumps would have operated during the winter period would have been in 2020 (1 out of 43 years)"[58] and as a result the Pumps would not affect the Rusty Blackbird. This statement is contradicted by FEIS Appendix A which documents that during the November to February winter waterfowl period,[59] Alternative 3 would have operated during 3 years (not 1 year) over the period of record as documented in FEIS Appendix A.[60] Over the period of record, Alternative 3 would have operated a total of 32 days in February and 7 days in January.[61]

(3) The FEIS response to comment 522 states that because Alternative 3 would rarely be used during the winter waterfowl period, "assessing impacts to Rusty Blackbirds would result in virtually no estimated impacts to the species."[62] This statement is not, and cannot be, supported by the record and demonstrates an incorrect understanding of native bird ecology. Rusty Blackbirds migrate and overwinter during multiple months that do not overlap with the November to February winter waterfowl period assessed in the FEIS. Rusty Blackbirds migrate and overwinter from late October through mid- to late-May.[63] Over the period of record, Alternative 3 would have operated in 17 years during these months, for a total of: 302 days in May, 224 days in April, 108 days in March, 32 days in February, and 7 days in January.[64]

---

[58] This appears to be based on the following personal communication referred to in the Waterfowl Appendix: "Furthermore, it is important to note that during the POR (1978-2020), only during January and February of 2020 would the pumps have been utilized during the winter waterfowl period (pers comm. Dave Johnson) as elevation 93 is rarely exceeded prior to spring precipitation events." FEIS, Waterfowl Appendix at 15. However, as noted above, this statement is contradicted by data in Appendix A.
[59] FEIS, Appendix F-5—Waterfowl at 22, Table D-13 ("Average of acres across all months of the winter waterfowl period (November-February); therefore, not a true representation of actual acres at any given time but rather used to account for DUDs over entire winter period.").
[60] FEIS, Appendix A—Engineering Summary at 148, Figure 2-108.
[61] FEIS, Appendix A—Engineering Summary at 148, Table 2-30.
[62] This appears to be based on the following personal communication referred to in the Waterfowl Appendix: "Furthermore, it is important to note that during the POR (1978-2020), only during January and February of 2020 would the pumps have been utilized during the winter waterfowl period (pers comm. Dave Johnson) as elevation 93 is rarely exceeded prior to spring precipitation events." FEIS, Waterfowl Appendix at 15. However, as noted above, this statement is contradicted by data in Appendix A.
[63] E.g., International Rusty Blackbird Working Group, ("Rusties depart from northern forests to begin their rather leisurely southward migration sometime in early to mid-September. They spend about one month resting and feeding at stopover sites between mid-October and mid-November, and they arrive on southeastern wintering grounds in late November. Including stopover time, autumn migration lasts 10-12 weeks. In spring, the impending breeding season urges the northward migration to progress much more quickly. Most birds leave the wintering areas in late March or early April and arrive on the breeding grounds a mere 2-4 weeks later.") available at https://rustyblackbird.org/species-information/migration/#:~:text=Rusties%20depart%20from%20northern%20forests,wintering%20grounds%20in%20late%20November.
[64] FEIS, Appendix A—Engineering Summary at 148, Figure 2-108 and Table 2-30.

(4) The FEIS response to comment 522 states that "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." This is directly contradicted by the FEIS. The Corps has proposed just "5,722 acres" of mitigation for Alternative 3, not the 7,650 acres of habitat referenced in the response to comment 523. According to the FEIS, the proposed mitigation for the damage to almost 90,000 acres of wetlands:

> involves acquiring and reforesting **up to 5,722 acres** of frequently flooded agricultural land as well as creating approximately 403 acres of moist soil units to mitigate for anticipated shorebird impacts. A multifaceted approach to mitigation planning will achieve the overall mitigation goals through the use of an existing in lieu fee program; USACE constructed mitigation sites; and/or the use of existing mitigation banks.[65]

Notably, the FEIS itself does not commit the Corps to implementing this unacceptably small amount of mitigation as the FEIS explicitly states that the Corps recommends acquisition and reforestation of "up to 5,722 acres." Multiple additional problems with the proposed mitigation are also discussed at length in the Conservation Organizations' comments on the DEIS and in Section G of these comments.

<u>FEIS Response to Comment 525</u>: In response to our comments regarding the inappropriate temporal restrictions on the DEIS analysis of waterfowl impacts, the FEIS response to comment 525 states that "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."

While we appreciate the Corps' engagement with other federal agencies, the Corps is the lead agency for this project and is responsible for ensuring full compliance with applicable laws and policies, including NEPAs requirement to assess the direct, indirect, and cumulative impacts of the proposed action. As extensively documented in the Conservation Organizations comments on the DEIS, the arbitrary temporal limitations on the DUD model mean that, among many other failings, the FEIS does **<u>not</u>** provide any information on: (1) impacts during spring migration, when 1.49 million waterfowl migrate through the Yazoo Backwater Area; (2) impacts during fall migration, when 1.32 million waterfowl migrate through the Yazoo Backwater Area; or (3) impacts to breeding waterfowl.

<u>FEIS Response to Comment 527</u>: In response to our comments regarding the need to assess impacts to waterfowl during the spring and fall migratory seasons, the FEIS response to comment 527 states: "As stated previously, based on the POR the fall migration period will not be impacted as the pump would not be operational." As highlighted above and in our comments on the DEIS, 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). Assessing impacts to migratory waterfowl requires an analysis of impacts during these critical migratory seasons using appropriately protective energetic values. Under the current DUD assessment, approximately 124 days of migratory impacts are not assessed. During spring migration Alternative 3 would have operated in 10 years over the period of record (1979, 1994, 1997, 2002, 2008, 2015, 2016, 2018, 2019, 2020), according to FEIS Appendix A.

[65] FEIS at v (emphasis added).

While we recognize that the current operations would likely be more limited during the fall migration season, the FEIS response to comment 527 incorrectly assumes that summer pumping has no effect on fall or winter habitat (i.e., water availability, soil moisture, and other critical parameters).

FEIS Response to Comment 530: In response to our comments on the DEIS shorebird analysis, the FEIS response to comment 530 provides a number of responses that further demonstrate the unacceptability of the FEIS shorebird analysis, including the following:

(1) The FEIS response to comment 530 states that the pumps would not have any impact on shorebirds migrating in the fall because the pumps would not operate during the fall migration. This response ignores the carry-over effects of pumping, including for example that reduced flood elevations in the summer will impact fall shorebird habitat and food supplies.

(2) The FEIS response to comment 530 states: "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." Contrary to this assertion, using a "broad swath" to identify shorebird impacts assumes that everything within this swath is equally (or overly) suitable, which it is not. As a result, this **underestimates** impacts.

(3) The FEIS response to comment 530 states: "While it is true that our model may be relatively 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 . . ." This response confirms one of our key objections to the Corps' shorebird model—the model is too simplistic to capture the important nuances in shorebird habitat requirements. As detailed in our comments on the DEIS, the shorebird analysis fails to account for many of the ecological characteristics of shorebirds and their habitat and the model outputs cannot provide a meaningful assessment of shorebird impacts.

FEIS Response to Comment 531: In response to our comments regarding the DEIS analysis of wading bird impacts, the FEIS response to comment 531 asserts that the model's reliance on a broad definition of foraging habitat translates into a conservative impact assessment:

> "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."

Contrary to the Corps' assertion, this approach does not provide a conservative assessment of impacts. Instead, it understates actual impacts to smaller species that utilize more specialized habitats. For example, the Corps' approach considers everything within 0-18 inches as suitable habitat (i.e., 0 inches is suitable habitat, 6 inches is suitable habitat, 12 inches is suitable habitat, etc.). Accounting for this large habitat niche as suitable means that the model will **understate** impacts to species with more narrow habitat niche requirements. The FEIS response to comment 531 also fails to address our comments regarding impacts outside of the nesting season.

E. The FEIS Does Not Address the Many Problems with the DEIS Water Quality Analysis

The FEIS fails to address or correct the many substantive problems with the analyses of impacts to water quality detailed in the Conservation Organizations' comments on the DEIS. Accordingly, the comments on the DEIS also apply fully to the FEIS and are incorporated by reference into these comments as though fully set forth herein.

The FEIS, like the DEIS, does not assess impacts to water quality within the Yazoo Backwater Area from the unacceptable degradation and loss of at least 89,628 acres of vital wetlands or from increasing agricultural productivity in the Yazoo Backwater Area.[66] Instead the FEIS contends that Alternative 3 will not result in any adverse impacts to water quality within the Yazoo Backwater Area because: (1) the pumps will not induce any additional agricultural production; and (2) the proposed mitigation measures will offset any loss of wetland pollutant-filtering capacity. These points are discussed below.

FEIS Response to Comment 499: The FEIS response to comment 499 brushes aside the potentially significant water quality impacts within the Yazoo Backwater Area with the following few sentences:

> 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 Conservation Organizations' highlight that the FEIS provides no factual support for the claim that "agricultural acres currently in production are likely managed for maximum productivity" or for the claim that the operating plan "is not believed to readily translate to significant additional inputs (fertilizer, pesticides) into future farming practices."

This response ignores the potential water quality impacts from the types of activities that are accounted for when the Corps' assesses agricultural benefits. This response is also directly contradicted by the operating plan for Alternative 3, the Corps' historic economic justifications for the Yazoo Pumps, and the fundamental purpose of the Yazoo Pumps project. For example:

---

[66] Of these, 89,407 acres will be damaged by operation of Alternative 3 plus at least 221.37 acres that will be destroyed during construction. An additional 96.58 acres of other Waters of the U.S. will also be damaged or destroyed. FEIS, Appendix F-3—Wetlands at 21; FEIS, Appendix I—404(b)(1) Evaluation at 31.

(1) When assessing agricultural benefits from flood damage reduction, the Corps accounts for such things as the benefits derived of earlier planting, among many other things. Such activities often require increased use of pesticides and herbicides to control pests and weeds; alterations in the timing and type of fertilizers applied; increased use of fertilizers that may be required as a result of earlier planting; and increased water withdrawals that could result from increased irrigation needs.

(2) The Alternative 3 operating plan is driven entirely by the desires and interests of industrial scale agricultural producers. Indeed, the operating plan is driven entirely by agricultural (and not flood) seasons with the differing operational levels established for the crop season and non-crop season.

(3) The 2007 Yazoo Pumps FEIS determined that 80% of project benefits are attributable to agriculture that would result from such things as earlier planting and the adoption of irrigation to improve efficiency.[67]

(4) The 1982 Yazoo Pumps FEIS determined that the project's primary benefits "would result from an increase in price levels, the increase in pump size, and the increase in agricultural development in the project area since authorization"[68] and noted that "almost all of the flood damages in the area are agricultural."[69] Annual benefits from the 1982 Yazoo Pumps included $15.73 million for agricultural intensification and $3.3 million for reducing flood damages to crops.[70]

(5) The 1941 authorization for the Yazoo Pumps (which is described in the 1941 Chief of Engineers Report on Flood Control on the Lower Mississippi River[71]) clearly states that the Yazoo Pumps were authorized to facilitate agriculture highlighting that the project was needed because as a result of other large-scale water resources projects, has "lost, to a large extent, such future prospects as otherwise they might have had in agriculture. . . ."[72] As a result, the authorization was limited to providing protection in areas that were considered suitable to agriculture in 1941: "lands inundated more frequently than once in every 5 years are not suited to agriculture and that the land below the 90-foot contour would therefore be dedicated to sump storage."[73] As a result, the authorized Plan C provides: "This plan again assumes that pumps of about 14,000 cubic feet per second

---

[67] Final Supplement No. 1 to the 1982 Yazoo Area Pump Project Final Environmental Impact Statement (2007)at Page 130-131, Table 26.2007 EIS, Economic Appendix at 7-41 ("All crop benefits result from a reduction of loss of production costs and increased expected net returns resulting from adoption of irrigation and earlier planting dates for the existing cropping pattern. This is possible because the alternatives analyzed reduce the extent, frequency, and duration of flooding, encouraging farmers to plant earlier and allowing them to make investments so they might irrigate later during periods during the growing season when water might be needed.").

[68] USACE, Record of Decision, Yazoo Area Pump Project Reevaluation Report, Yazoo Backwater Area, Yazoo Basin, Mississippi, July 18, 1983.

[69] Yazoo Area Pump Project Reevaluation Report, Volume 2, Technical Report, July 1982 at C-9, Paragraph 34.

[70] Yazoo Pump Project Yazoo Backwater Area Mississippi Reevaluation Report, Appendix F—Economic Analysis at F-10 and Table F-8.

[71] 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).

[72] Id at 37.

[73] Id. at 40.

> capacity would be provided to prevent the sump level from exceeding 90 feet, mean Gulf level, at average intervals of less than 5 years."[74]

<u>FEIS Response to Comment 499 and Comment 500</u>: The FEIS response to comments 499 and 500 assert that the proposed mitigation will offset all water quality problems that may arise from construction and operation of the Yazoo Pumps:

> 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.[75]
>
> * * *
>
> 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.[76]

As discussed at length in these comments and in the Conservation Organizations' comments on the DEIS, the proposed mitigation plan is fundamentally flawed including because the FEIS: (i) does not identify the full amount of mitigation required to offset the project's highly significant adverse impacts; (ii) does not propose enough mitigation to offset the adverse impacts that has identified; and (iii) does not establish the mitigation mandates and ecological success criteria needed to offset impacts.

F. The FEIS Cumulative Impacts Assessment is Fundamentally Flawed

The Conservation Organizations appreciate the inclusion of a stand-alone cumulative impacts section in the FEIS, which is required by the National Environmental Policy Act and was requested in our DEIS comments. The FEIS cumulative impacts section, however, does not comply with the longstanding legal requirements for meaningfully assessing cumulative impacts and draws conclusions that are not—and cannot be—supported by the record. These problems are discussed below.

1. The Cumulative Impacts Analysis Does Not Comply with the Law

The FEIS cumulative impacts section does not comply with longstanding caselaw, which makes it clear that 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

[74] Id. at 40.
[75] FEIS Response to Comment 499.
[76] FEIS Response to Comment 500.

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.[77]

This standard has been reconfirmed repeatedly, including in March 2024 by the U.S. District Court for the District of Columbia:

> "NEPA's implementing regulations require an agency to evaluate 'cumulative impacts' along with the direct and indirect impacts of a proposed action." TOMAC, Taxpayers of Mich. Against Casinos v. Norton, 433 F.3d 852, 864 (D.C. Cir. 2006). Cumulative impacts are "the incremental effects of the action when added to the effects of other past, present, and reasonably foreseeable actions regardless of what agency ... or person undertakes such other actions. [They] can result from individually minor but collectively significant actions taking place over a period of time." 40 C.F.R. § 1508.1(g)(3). Building on this definition, the D.C. Circuit has held that "a meaningful cumulative impact analysis must identify five things: (1) the area in which the 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." TOMAC, 433 F.3d at 864 (quotation marks omitted). "In other words, the agency cannot treat the identified environmental concern in a vacuum." Id. (quotation marks omitted).[78]

As a result, it is not enough for the FEIS to simply catalog past, present, and reasonably foreseeable future actions. The FEIS 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 many courts have made clear. For example:

> Agencies must "take a hard look at all actions that may combine with the action under consideration to affect the environment." *Great Basin Res. Watch*, 844 F.3d at 1104 (quotation marks, emphasis, and alterations omitted). Agencies must provide "useful analysis" including "quantified or detailed information" of how past, present and future projects will combine with the proposed project to impact the environment. *Great Basin Mine Watch*, 456 F.3d at 971–72 (citations and quotation marks omitted). "[G]eneral statements about possible effects and some risk do not constitute a hard look absent a justification regarding why more definitive information could not be provided." *Ocean Advocates v. U.S. Army Corps of Engineers*, 402 F.3d 846, 868 (9th Cir. 2005) (quoting *Neighbors of Cuddy Mountain v. U.S. Forest Serv.*, 137 F.3d 1372, 1379 (9th Cir. 1998)). "The cumulative impact analysis must be more than perfunctory; it must provide a 'useful analysis of the cumulative impacts of past, present, and future projects.'" *Kern v. U.S. Bureau of Land Mgmt.*, 284 F.3d 1062, 1075 (9th Cir. 2002) (quoting *Muckleshoot*

[77] E.g., TOMAC, Taxpayers of Michigan Against Casinos v. Norton, 433 F.3d 852 (D.C. Cir. 2006) (quoting Grand Canyon Trust, 290 F.3d at 345); Dine Citizens Against Ruining Our Env't v. Haaland, 59 F.4th 1016, 1039–40 (10th Cir. 2023); Theodore Roosevelt Conservation P'ship v. Salazar, 616 F.3d 497, 503 (D.C. Cir. 2010); 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).

[78] Dakota Res. Council v. U.S. Dep't of Interior, No. 22-CV-1853 (CRC), 2024 WL 1239698, at *9 (D.D.C. Mar. 22, 2024).

Indian Tribe v. U.S. Forest Serv., 177 F.3d 800, 810 (9th Cir. 1999)).[79]

The cumulative impacts analysis in the FEIS does not meet these standards. For example, the FEIS does not discuss the impacts of the many extremely large-scale and environmentally damaging water resources projects that have been built in the Yazoo Backwater Area by the Corps.[80] Individually and collectively, these projects have had profound adverse impacts on wetlands, wildlife, and water quality in the Yazoo Backwater Area. But the FEIS does nothing more than provide a list of these projects followed by the perfunctory conclusion that they have caused "further alterations that have and continue to influence area hydrology."[81]

A meaningful cumulative impacts analysis must carefully assess and account for the highly significant impacts of these large-scale water resources projects—impacts that are clearly known to the Corps because the Corps is the agency that planned, constructed, and continues to operate these projects. Indeed, the Corps has known since at least 1959 that other water resources projects had produced highly significant hydrologic changes to the project area that rendered construction of the Yazoo Pumps unnecessary:

> 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 improvements 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 higher degree of protection for the foreseeable future without the necessity of pumping.[82]

The FEIS also does not identify the full array of reasonably foreseeable future actions in the Yazoo Backwater Area or discuss the likely impacts of those actions. For example, in its comments on the DEIS the Mississippi Levee Board stated that they would be raising the elevation of the Yazoo Backwater Levee by at least 5.8 feet within "the next few years" which will also require modifications to the Steele Bayou Structure:

> 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

---

[79] Concerned Citizens & Retired Miners Coal. v. United States Forest Serv., 279 F. Supp. 3d 898, 919–20 (D. Ariz. 2017).
[80] The FEIS identifies some, but not all, of these projects by name, while providing no description of the project nor description or evaluation of the impacts of these projects. The FEIS limits its identification of these past projects to "water resources projects, such as such as the Mississippi River levee, Yazoo Area, and Satartia Area Backwater Levee Projects, connecting channel and structures, Holly Bluff cut-off, Steele Bayou, Upper Steele Bayou, Big Sunflower, and Will M. Whittington (Lower)Auxiliary channel and levees projects." FEIS at 177.
[81] FEIS at 177.
[82] Office of the District Engineer, Corps of Engineers, Mississippi River and Tributaries Comprehensive Review Report, Annex L (1959).

> 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.[83]

However, the FEIS cumulative impacts section does not even mention, let alone assess, the likely impacts (including the likely very significant adverse impacts to wetlands) from these reasonably foreseeable future projects.

The FEIS must, but does not, meaningfully assess the highly significant cumulative impacts of these many past, present, and reasonably foreseeable future actions in conjunction with the impacts of Alternative 3. Given the significant adverse impacts from these actions, the significant harm that would result from Alternative 3—including damage to 89,628 acres of wetlands and significant additional reductions in flood stages—could could 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 could be the proverbial straw that breaks the camel's back pushing species to or past their tipping points.

2. The Cumulative Impacts Analysis Draws Conclusions that Are Insupportable

The FEIS cumulative impact draws conclusions that are not, cannot be, supported and that in many cases are directly contradicted by information in the FEIS. Notably, the FEIS concludes that the past, present, and reasonably foreseeable future actions in the project area have had the following benign impacts on the hemispherically significant wetlands in the Yazoo Backwater Area:

> Over time, wetland extent in the YSA has contracted and expanded due to the combination of environmental impacts and conservation efforts (Appendix F-3)[84].

The FEIS then concludes that the "incremental impact" of the Yazoo Pumps "(considering both Recommended mitigation acreage and project features), when added to former, present, and foreseeable future actions, results in no new additional net losses to environmental resources within the study area."[85]

Both of these conclusions are directly and fundamentally contradicted by information contained in the FEIS, the Clean Water Act veto, in public comments, and the scientific literature. For example:

(1) The FEIS acknowledges that Alternative 3 will adversely impact at least 89,628 acres of wetlands.

(2) The FEIS acknowledges that more than half of the MAV bottomland hardwood forest area has been lost through conversion to agricultural uses.[86]

---

[83] FEIS, Appendix B—Public Comments at Response to Comment 251.
[84] FEIS at 177.
[85] FEIS at 178.
[86] FEIS at 177.

(3) The FEIS acknowledges that approximately 139,701 acres of bottomland hardwoods, roughly 33 percent of forested wetlands" in the Yazoo Backwater Area have been lost within just the 98.2-foot elevation."[87]

(4) The FEIS Adaptative Management Memorandum of Agreement documents that the Corps, EPA, and USFWS agree that: "Bottomland hardwood wetlands and other wetlands in the Yazoo Backwater Study Area, or YSA, depend upon frequent saturation and inundation to provide critical ecosystem functions and services to humans and wildlife (Wharton et al. 1982, Dahl et al. 2009). Yet this habitat has declined by more than 80 percent locally, primarily due to the large-scale conversion of fertile, frequently flooded land to agriculture since the late 1800s."[88]

(5) The FEIS acknowledges that the flood regime has been further reduced due to "stream channelization, installing drainage structures, and initiating groundwater pumping for irrigation" in the Yazoo Backwater Area.[89]

(6) The FEIS acknowledges that many, large-scale water resources projects have been built in the Yazoo Backwater Area causing "further alterations that have and continue to influence area hydrology." These projects include the: (i) Mississippi River Levee, (ii) Yazoo Area Backwater Levee; (iii) Satartia Area Backwater Levee; (iv) Connecting channel and structures; (v) Holly Bluff cut-off; (vi) Steele Bayou; (vii) Upper Steele Bayou; (viii) Big Sunflower; and (ix) Will M. Whittington (Lower) Auxiliary channel and levees projects. As discussed below, these projects have had a profound effect on the hydrology of the Yazoo Backwater Area, and those impacts are clearly known by the Corps.

(7) The FEIS acknowledges that "[c]limate change patterns have also influenced flood regimes and stream baseflows" in the Yazoo Backwater Area.

(8) The FEIS acknowledges that in the Yazoo Backwater Area "bottomland hardwood forests have become fragmented with agricultural fields and roads, and project rights-of-way, which have indirectly caused soil deposition and reforestation along new stream channels."

(9) The FEIS acknowledges that "hydrologic modifications coupled with increased groundwater withdrawal for agricultural have led to low baseflows during seasonal dry periods which have been dewatering mussel beds, reducing fish diversity, and impacting other sensitive environments within the Yazoo Basin."

(10) In its comments on the DEIS, the Mississippi Levee Board asked that the FEIS "contain all the data and results of the Recommended Plan going forward" and particularly highlighted that "the current 100-year flood for the area is 100.5' and with the

[87] FEIS at 177.

[88] Memorandum of Agreement Between the U.S. Army Corps of Engineers, the U.S. Environmental Protection Agency and the U.S. Fish and Wildlife Service Concerning The Yazoo Backwater Water Management Plan Monitoring And Adaptive Management Plan (November 25, 2024) at Appendix I, Page 5.

[89] FEIS at 177.

implementation of the 25,000 cfs pump it will drop the 100-year flood to 93.5'." The Corps did not disagree with this statement.[90]

(11) The FEIS' Notice of Intent 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.[91]

(12) The Corps' 2020 Yazoo Pumps FSEIS acknowledges 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 a very short period of time. At least some of these significant changes 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.[92]

(13) In 2009, the USFWS determined that from just the 1970s to 2006, the Yazoo Backwater Area lost 11 percent of its remaining forested wetlands.[93]

(14) In 2008, EPA determined in the Clean Water Act veto that 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.[94]

(15) In 1988, the Department of the Interior determined that the majority of the wetland losses in the Lower Mississippi Alluvial Valley had been traced directly to the effects of federal flood control and drainage projects.[95]

(16) In 1982, the Corps determined that "Land clearing for agricultural uses has reduced the original forested area by almost 74 percent."[96] The Corps also determined that "the

---

[90] FEIS, Appendix B—Public Comments at Response to Comment 251.
[91] Comparing elevations provided at 88 Fed. Reg. at 43103, with elevations provided at 2007 EIS, Appendix 6 at page 6-44.
[92] 2020 FSEIS, Appendix F-5 (Wetlands) at 35-36.
[93] 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).
[94] 2008 Clean Water Act Final Determination at iii.
[95] 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.
[96] 1982 FEIS, Volume 2 Technical Report at A-13, paragraph 32.

widespread use of agricultural chemicals, together with heavy suspended sediment loads washed into area streams and lakes from agricultural areas, has contributed greatly to the loss and degradation of aquatic and terrestrial wildlife habitat in the Delta."[97]

(17) In 1982, the Corps determined that "The use of agricultural chemicals in the Delta has had considerable impact on the biological environment of the project area. Pesticide residues have been found in tissue, water, and mud samples. In many cases, pesticide levels in lakes and rivers evaluated have been high enough to be suspected of interfering with the productivity of biota in the area, particularly animals high in the aquatic food chain such as largemouth bass and herons. In high enough concentrations, pesticides may also reduce the numbers of aquatic food organisms, and at sublethal levels, may adversely affect growth, reproduction, and behavior of higher animals which ingest pesticide contaminated organisms."[98]

G. The FEIS Does Not Address the Many Problems with the DEIS Mitigation Analysis and Compensatory Mitigation Plan

The FEIS does not address or correct the many fundamental problems with the mitigation analysis and compensatory mitigation plan detailed in the Conservation Organizations' comments on the DEIS—including the failure to assess the full array of impacts that must be mitigated as a matter of law and the failure to effectively avoid and minimize adverse impacts. Accordingly, the comments on the DEIS also apply fully to the FEIS and are incorporated by reference into these comments as though fully set forth herein. The Conservation Organizations provide the following additional comments regarding the FEIS mitigation analysis and compensatory mitigation plan.

As noted in Section B of these comments, the FEIS proposes "acquiring and reforesting **up to 5,722 acres** of frequently flooded agricultural land" and "creating approximately 403 acres of moist soil units" to mitigate the damage to almost 90,000 acres of wetlands.[99] The Corps will employ a "multifaceted approach to mitigation planning will achieve the overall mitigation goals through the use of an existing in lieu fee program; USACE constructed mitigation sites; and/or the use of existing mitigation banks."[100]

This approach suffers from a number of fatal flaws including the following:

(1) As discussed at length in our comments on the DEIS and in these comments, the FEIS has not assessed the full extent of the adverse impacts from Alternative 3. As a result, the proposed amount of mitigation cannot replace lost functions and values or satisfy the Corps' mitigation requirements. As explicitly recognized by longstanding caselaw:

> The agency cannot reliably conclude that the selected project has minimized adverse impacts on aquatic ecosystems to the extent practicable when its habitat mitigation calculations are infected with an underestimate of the floodplain habitat impacted. 40 C.F.R. § 230.10(d); *see Ohio Valley Envtl. Coalition v. United States Army Corps of Eng'rs,* 479 F.Supp.2d 607, 627 (D.W.Va.2007) ("[u]nless the effects of

[97] 1982 FEIS, Volume 2 Technical Report at A-17, paragraph 46.
[98] 1982 FEIS, Volume 2 Technical Report at A-18, paragraph 48.
[99] FEIS at v (emphasis added).
[100] FEIS at v (emphasis added).

the activity are properly identified, the agency has not met its legal obligation and any proposed mitigation measures dependent upon an incomplete environmental impact analysis necessarily fail[;]") (appeal pending). The finding of full mitigation in spite of this omission was arbitrary and capricious.[101]

(2) The FEIS does not commit the Corps to implement the already unacceptably small amount of mitigation. Instead, the FEIS explicitly states that the Corps intends to acquire and reforest "up to 5,722 acres."

(3) The FEIS response to comment 463 states that "Wetland mitigation requirements were higher than aquatic impacts, so mitigating for wetlands will fully compensate for aquatics, even beyond the Envirofish calculations." As discussed at length in our DEIS comments, this approach to mitigation cannot and does not ensure replacement of, or offsets to, "damages to ecological resources, including terrestrial and aquatic resources, and fish and wildlife losses" as required by law.[102] To the contrary, this approach allows predicted gains in some functions to count as mitigation for the loss of other critical functions that may not be replaced. As the USFWS thus made clear, "[t]he total mitigation required to compensate aquatic and terrestrial habitat is ***not*** additive."[103] The mitigation proposed in the FEIS also suffers from many, if not all, of the same problems identified in the Clean Water Act veto.[104]

(4) The acquisition and reforestation of frequently flooded agricultural lands does not ensure mitigation for the loss and reduction in the extent of overbank flooding that is critical for fish spawning and rearing. This problem is highlighted by the success criteria established in the Ducks Unlimited In-Lieu Fee program, which the FEIS identifies as the primary tool for mitigation[105] and which is anticipated to be able to provide the full amount of fisheries and aquatic resources mitigation.[106] As documented in the proposed Ducks Unlimited In-Lieu Fee program instrument:

[101] Env't Def. v. U.S. Army Corps of Eng'rs, 515 F. Supp. 2d 69, 83 (D.D.C. 2007).
[102] 33 U.S.C. § 2283(d).
[103] FEIS Appx. D-2 at 13.
[104] See, e.g., Clean Water Act, Appendix 1 at 23, 32, 34, 57-58.
[105] FEIS at 179 ("Compensatory mitigation is proposed to be provided through utilization of an in-lieu fee (ILF) program servicing the project area and would consist of bottomland hardwood reforestation of frequently flooded agricultural land, aquatic and shorebird reforestation. The only ILF program which services the project area is the Ducks Unlimited Mississippi Delta Program (project number MVK-2009-198)."); FEIS Appendix J—Compensatory Mitigation Plan at 43 ("The recommended plan for compensatory mitigation in the Yazoo Backwater Management Plan is to persue [sic] a plan with Duck's Unlimited In-Lieu Fee program. The plan presented throughout this document is a backup plan in case the In-Lieu Fee program is not successful (not meeting or exceeding USACE standards).").
[106] Compare Draft Instrument Amendment to add the Yazoo Backwater Preserve Project to the Ducks Unlimited Mississippi Delta In-Lieu Fee Program Prepared by Ducks Unlimited (5 November 2024) at 28 (the sites are expected to provide fisheries offsets of at least 3,851 ADFAs) with FEIS at 82, Table 182 (identifying needed fisheries mitigation of 3,851 ADFAs).

The Success Criteria will follow those outlined in the Vicksburg as outlined below:
Wetland:
• **Wetland Hydrology.** The hydrology monitoring should display wetland hydrology which is defined as whether the site is inundated (flooded or ponded) **or the water table is ≤12 inches below the soil surface for ≥14 consecutive days during the growing season at a minimum frequency of 5 years in 10 (≥50% probability**) (ERDC TN-WRAP-05-2). **Any combination of inundation or shallow water table is acceptable in meeting the 14-day minimum requirement**. Short-term monitoring data may be used to address the frequency requirement if the normality of rainfall occurring prior to and during the monitoring period each year is considered. A site must be inundated or saturated typical of a reference condition for the same HGM hydrology classification. A site must meet wetland hydrology criteria as described in the USACE Wetland Delineation Method, 1987 Manual /or Atlantic/Gulf Coast Regional Supplement.[107]

These wetland hydrology criteria do not ensure effective mitigation for floodplain spawning and rearing habitat, including because floodplain dependent fish cannot spawn or rear in moist soil regardless of when, for how long, or how often the soil is moist.

These wetland hydrology criteria also do not ensure that floodplain fish will be able to access the floodplain for spawning and rearing. As long recognized by relevant caselaw:

> The agency's failure to incorporate known access issues into its mitigation calculation and to identify evidence supporting its determination that reduced access will be insignificant amounts to a failure to present a "complete analytic defense of its [habitat] model," *Sierra Club v. Costle,* 657 F.2d 298, 333 (D.C.Cir.1981) (internal quotations omitted) *rev'd on other grounds,* 463 U.S. 680, 103 S.Ct. 3274, 77 L.Ed.2d 938 (1983). This omission violates NEPA (requiring "scientific integrity" in environmental impact statements, 40 C.F.R. 1502.24), and undermines the Corps' conclusion that the project complies with CWA (mandating "appropriate and practicable steps ... [to] minimize potential adverse impacts ... on the aquatic ecosystem," 40 C.F.R. 230.10(4)).[108]

(5) The proposed monitoring plan for the Corps' primary approach to mitigation (the Ducks Unlimited In-Lieu Fee program) is limited to 5 to 10 years, depending on which of the two different monitoring requirements identified will be followed. These periods are too short to determine mitigation success.

[107] Draft Instrument Amendment to add the Yazoo Backwater Preserve Project to the Ducks Unlimited Mississippi Delta In-Lieu Fee Program Prepared by Ducks Unlimited (5 November 2024) at 39.
[108] Env't Def. v. U.S. Army Corps of Eng'rs, 515 F. Supp. 2d 69, 81 (D.D.C. 2007). Under the current NEPA implementing regulations, the requirement to ensure scientific integrity in environmental impact statements is set forth at 40 C.F.R. 1506.4, 1506.6, and 1507.2.

> The performance standards criteria described below will be monitored over a five-year term that begins following the submittal of a post-construction as-built; the monitoring term includes three interim goals, and the final success criteria.[109]
>
> * * *
>
> Monitoring reports shall be provided to USACE no later than October 15th following the growing seasons in Years 1, 3, and 5, 7, 10 so that any corrective measures by the Sponsor may be undertaken.[110]

Monitoring under this program also may, or may not, include an appropriate number of wells to effectively monitor hydrology. The latest proposal for the Ducks Unlimited In-Lieu Fee program states that the "installation of appropriate hydrologic monitoring devices, groundwater wells or piezometers" will be undertaken "[w]hen needed, as determined by the IRT".[111] If required, these wells will "be installed at a rate of one monitoring well for every 200 acres of restored bank area."[112] The Ducks Unlimited In-Lieu Fee program also fails to include the required detailed work plans.

(6) At best, the Ducks Unlimited In-Lieu Fee program assumes that a 1:1 mitigation acreage ratio will fully replace lost functions. The FEIS provides no support or justification for relying on such a meager mitigation ratio and there is no basis for making such a determination including because the conditions at the likely mitigation sites have not yet been evaluated. The same is true for the other mitigation options proposed in the FEIS.

(7) The Corps cannot know if there are enough available mitigation credits in the Ducks Unlimited In-Lieu Fee program because the targeted mitigation sites have not been secured and the existing conditions (and post-project conditions) for the targeted mitigation sites have not been assessed. The same is true for the other mitigation options proposed in the FEIS.

(8) The Ducks Unlimited In-Lieu Fee program amendment—which is highly relevant to the FEIS—was not provided with the DEIS or the FEIS. The Conservation Organizations also did not receive the November 7, 2024, public notice announcing the availability of the draft instrument modification to the Ducks Unlimited Mississippi Delta In-Lieu Fee Program from the Corps. We highlight that this public notice was not sent to the Conservation Organizations even though a number of our organizations are signed up to receive all Vicksburg District regulatory notices and have (and continue to) routinely received Vicksburg District regulatory notices not related to the Yazoo Pumps.

(9) The proposed mitigation will be located in the same area adversely affected by the construction and operation of Alternative 3 but does not account for those adverse impacts to wetland hydrology in the proposed amount of mitigation. The FEIS also does

---

[109] Draft Instrument Amendment to add the Yazoo Backwater Preserve Project to the Ducks Unlimited Mississippi Delta In-Lieu Fee Program Prepared by Ducks Unlimited (5 November 2024) at 39.
[110] Id. at 41.
[111] Id. at 40.
[112] Id. at 40.

not account for the potential adverse impacts to mitigation sites if the operating plan is changed. *See* Section I.2. of these comments.

(10) The FEIS response to comment 488 states, among other things, that the proposed mitigation addresses "significant effects on fish and wildlife resources according to USACE Civil Works policy." Even if this was an accurate statement (which it is not), this would not meet the mitigation requirements for the Corps' civil works projects. Provisions established through several Water Resources Development Acts require the Corps to mitigate all losses (not just "significant" losses) to fish and wildlife created by a project.[113]

(11) The FEIS may not properly rely on adaptive management and possible future adjustments to help justify the adequacy of its compensatory mitigation plan. As the courts have ruled, while NEPA does not require a complete mitigation plan,

> The public is nevertheless entitled to an accurate EIS that indicates whether a project's environmental impacts "can be fully remedied by, for example, an inconsequential public expenditure, [or whether they will be] only be modestly ameliorated through the commitment of vast public and private resources." *Id.* In defending its mitigation calculation, the Corps repeatedly assures the Court that its mitigation team will implement, monitor, and adjust mitigation techniques so as to balance the project's twin aims of flood control and environmental protection. If such assurances were allowed to paper over the flaws in the Corps' mitigation analysis, however, they would effectively gut the environmental safeguards that Congress enacted in the CWA and NEPA.[114]

H. Independent External Peer Review is Required as a Matter of Law

Neither the FEIS nor DEIS have been reviewed by an independent external peer review panel as required by law and as requested in our comments on the DEIS and in letters to the Corps. The many problems with the analyses in both the FEIS and DEIS exemplify the critical substantive need for the mandatory independent external peer review.

In its response to comments, the Corps contends that an independent external peer review is not required because the EIS "is not a feasibility study or reevaluation report." According to the DEIS:

> 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.[115]

---

[113] 33 U.S.C. § 2283(d)(1).
[114] *Env't Def. v. U.S. Army Corps of Eng'rs*, 515 F. Supp. 2d 69, 84–85 (D.D.C. 2007) (citing *Robertson v. Methow Valley Citizen's Council,* 490 U.S. 332, 352 (1989).
[115] FEIS Response to Comment 9. The Corps has not provided any type of documentation related to this decision.

This statement is unavailing, however, as the FEIS clearly falls under the statutory definition of a "project study" for purposes of IEPR:

> The term "project study" means— (A) a feasibility study or reevaluation study for a water resources project, including the environmental impact statement prepared for the study; and (B) **any other study associated with a modification of a water resources project that includes an environmental impact statement**, including the environmental impact statement prepared for the study.[116]

Subsection (B) of this definition makes clear that IEPR is required for "any study" associated with a modification of a water resources project that is not a feasibility report or a reevaluation study. The FEIS is unquestionably associated with a modification of the Yazoo Pumps project authorized in 1941.

The Corps' own actions also make clear that mandatory IEPR is required for a project study that meets the mandatory IEPR cost or controversy triggers even if that study is not a feasibility or reevaluation report. For example:

(1) In 2016, the Corps determined that mandatory IEPR was required for the Mississippi River Between the Ohio and Missouri Rivers (Regulating Works) Supplemental Environmental Impact Statement (SEIS).[117] This study was not a feasibility or reevaluation report, as documented in the project's peer review plan:

> "Decision Document. The Congress of the United States, through a series of Rivers and Harbors Acts beginning in 1824, authorized the U.S. Army Corps of Engineers to provide a safe and dependable navigation channel on the Middle Mississippi River (MMR), that portion of the Mississippi River between the confluences of the Ohio River and the Missouri River. The most recent authorization stipulates a channel that is 9 feet deep and not less than 300 feet wide, with additional width in bends as required. The purpose of the SEIS is to update the 1976 EIS with new information and evaluate impacts of the current Regulating Works Project. At this time, it is not anticipated that additional Congressional authorization will be required."[118]

(2) In 2012, the Corps determined that mandatory IEPR was required for the Chicago Area Waterway System (CAWS) Dredged Material Management Plan (DMMP) and Integrated Environmental Impact Statement (EIS).[119] This study was not a feasibility or reevaluation report, as documented in the project's peer review plan:

---

[116] 33 U.S.C. § 2343(l)(1) (emphasis added).
[117] Mississippi River Between the Ohio and Missouri Rivers (Regulating Works) Supplemental Environmental Impact Statement (SEIS), St. Louis District (approved February 17, 2016) at 10 ("Since significant controversy or disagreement may arise during the production and/or review of the SEIS, a Type I IEPR will be performed for the SEIS, scoped accordingly for an environmental compliance document.") (available at https://www.mvs.usace.army.mil/Portals/54/docs/pm/PeerReview/Redacted/RegulatingWorksSEISReviewPlanApprovedFeb2016Redacted.pdf).
[118] Id. at 1-2.
[119] Review Plan, Calumet Harbor and River, Illinois and Indiana Dredged Material Management Plan Chicago (approved October 4, 2012) at 6 (available at https://www.dvidshub.net/publication/issues/69096).

> "Decision Document. The Calumet Harbor and River Dredged Material Management Plan (DMMP) Study will produce a DMMP Report and integrated Environmental Assessment. The report will identify a recommended plan for the management of dredged material from Calumet Harbor and River for at least the next twenty years. USACE policy (ER 1105-2-100, E-15.a) is to accomplish disposal of dredged material in the least costly manner that is consistent with sound engineering practices and environmental standards. The DMMP Report will include an Environmental Assessment (EA) of the alternative plans. If the EA determines that there are significant environmental effects, the EA will be converted to an Environmental Impact Statement (EIS). HQUSACE is responsible for final approval of the DMMP. The DMMP will not require Congressional authorization."[120]

(3) In 2009, the Corps determined that mandatory IEPR was required for a supplemental EIS for the St. Johns Bayou and New Madrid Floodway Project.[121] This study was not a feasibility or reevaluation report, as documented in the project's peer review plans:

> "Decision Document. The St. Johns Bayou and New Madrid Floodway Project is an existing authorized project with a portion of it already constructed. The purpose of this document is to document the requirements outlined by NEPA. If determined feasible, a ROD will be signed by the MVD Commanding General. If necessary, a post authorization report will be prepared."[122]

As detailed in the Conservation Organizations Comments on the DEIS, IEPR is mandatory for the Yazoo Pumps EIS because Alternative 3 and any variation of the Yazoo Pumps would cost well over $200 million.[123] IEPR is also mandatory for Alternative 3 and any derivation of the Yazoo Pumps because the Yazoo Pumps unquestionably satisfy the IEPR controversy triggers because: "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."[124]

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.

I. The Memorandum of Agreements Do Not Prevent or Prohibit Additional Adverse Impacts

At some point after the FEIS was released on November 29, 2024, the Corps posted three Memorandums of Agreement (MOA) on the Yazoo Backwater Area project website.[125] These MOAs do

[120] Id. at 1-2.
[121] Review Plan St. Johns Bayou and New Madrid Floodway, MO, Environmental Impact Statement, Memphis District (March 2009); see also, Review Plan Update for the St. Johns Bayou and New Madrid Floodway Project (2016) (available at https://www.mvm.usace.army.mil/Portals/51/docs/PPPMD/Peer%20Review%20Plans/RevisedFinalSJNMReviewPlan.pdf).
[122] March 2009 Review Plan St. Johns Bayou and New Madrid Floodway at 3; 2016 Review Plan Update for the St. Johns Bayou and New Madrid Floodway Project at 3.
[123] 33 U.S.C. § 2343(a).
[124] 33 U.S.C. § 2343 (a)(4).
[125] https://www.mvk.usace.army.mil/Missions/Programs-and-Project-Management/Yazoo-Backwater/.

not prevent or prohibit adverse impacts that will add to the already unacceptable damage from Alternative 3, as discussed below. While the Conservation Organizations appreciate that the Corps posted these MOAs, no public notice was provided regarding the availability of the MOAs. As a result, most members of the public are unlikely to know that the MOAs have been posted or are available for review.[126]

1. The Operating Plan MOA Does Not Prevent Ecologically Damaging Changes to Operations

As discussed in detail in the Conservation Organizations' comments on the DEIS, the operating plan for Alternative 3 can, and likely will, change over time. As documented in the FEIS, even small changes in the operating regime can translate into significant additional harm.[127] If the operating plan does change, project-induced impacts could increase well above the already unacceptable levels currently identified in the FEIS. Significant additional impacts could also occur through recurring deviations from the operating plan, which are allowed under the Corps' regulations.[128]

The Operating Plan MOA[129] posted on the Corps' project website does not prevent or minimize the risk of operating plan changes that would result in even more harm to the wetlands and wildlife in the Yazoo Backwater Area. To the contrary, the Operating Plan MOA allows the Corps to freely change the operating plan, for at least the following reasons:

(a) The Operating Plan MOA does not ensure that future operating plan changes will not result in unacceptable adverse impacts that alone, or in combination with the adverse impacts from implementation of Alternative 3, will violate the 2008 Clean Water Act veto. The Operating Plan MOA also does not ensure that EPA could act to enforce the veto to prevent any such future violation.

(b) The Operating Plan MOA does not prevent adoption of a revised operating plan that would result in adverse impacts that violate the 2008 Clean Water Act veto. At most, the Operating Plan MOA requires the Corps to obtain concurrence from EPA regarding the adequacy of mitigation for any additive impacts from changes to the operating plan.[130]

(c) The Operating Plan MOA is not binding on any party, is not enforceable, does not create any actual obligation, and does not apply to any person outside of the Corps, EPA, and USFWS. As stated explicitly in the Operating Plan MOA: "This MOA is not legally binding, does not

---

[126] The Conservation Organizations only became aware that the MOAs had been posted because we regularly check the Yazoo Pumps project website to see if new information has been posted.

[127] 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. FEIS Main Report and Wetland Appendix F-3.

[128] ER 1110-2-240, Water Control Management (30 May 2016) at paragraph 3-2j.

[129] Memorandum of Agreement Between the U.S. Army Corps of Engineers, the U.S. Environmental Protection Agency and the U.S. Fish and Wildlife Service Concerning the Yazoo Backwater Water Management Plan Pump and Water Control Structure Operation Plan, November 25, 2024 (hereafter the "Operating Plan MOA).

[130] Operating Plan MOA at 3, paragraph III.b and III.d. The Operating Plan MOA does not require an assessment of whether the cumulative impacts of the proposed operating plan changes: (a) violate the 2008 Clean Water Act veto; (b) are otherwise unacceptable under Clean Water Act 404(c); or (c) cause the project to violate the Clean Water Act 404(b)(1) Guidelines.

create any contractual obligation, and is not enforceable by any party. . . . This MOA does not apply to any person outside of the USACE, the EPA and the USFWS."[131]

(d) The Operating Plan MOA does not affect or limit the Corps' authorities and implementing regulations, including the implementing regulations that allow recurring deviations from operating plans.[132] As a result, the Corps can implement recurring operational changew that deviate from the operating plan without triggering the Operating Plan MOA.

(e) The Operating Plan MOA does not require the Corps to obtain approval from EPA or USFWS before making changes to the operating plan. Instead, any changes proposed by the Corps are simply to be "done in concert with the EPA and the USFWS."[133] The only limitation adopted by the MOA is for the Corps' Vicksburg District to "obtain concurrence from the EPA" that the adverse environmental impacts from any changes to the operating plan "have been adequately mitigated" before the Corps implements those changes.[134]

(f) The Operating Plan MOA does not require the Corps to provide the public with notice of any proposed change or non-emergency deviation. The MOA also does not require the Corps to obtain public input or comment on any proposed operating plan changes.[135]

(g) The Operating Plan MOA highlights the Corps' ability to deviate from the approved water control plan for a wide variety of reasons, including "to mitigate an imminent threat to . . . property or the environment." While the MOA provides some examples of the types of imminent threats that would justify an emergency deviation, many other situations could be interpreted or misinterpreted by the Corps to fall under the emergency deviation exclusion. For example, under the emergency deviation provision, the Corps could act to "mitigate an imminent threat" to farmland or crops located below the 2-year floodplain elevation by turning the pumps on well below the operating plan's 89.5-foot pumps-on trigger.

(h) The Operating Plan MOA acknowledges that that substantial, long-standing deviations from Corps operating plan requirements are fine. As documented in the MOA, the Corps historically has—and will continue to—not follow the requirements of the related 1985 Water Control Manual for Steele Bayou.[136]

(i) The Operating Plan MOA is to be reviewed by the agencies "10 years from the date of the award of the first construction contract for the Project." Under this schedule, the Operating Plan MOA could be revised before construction is completed and/or before the first year that the pumps will need to be operated.

[131] Operating Plan MOA at 2, paragraph I.c.
[132] Id.
[133] Operating Plan MOA at 3, paragraph III.a.
[134] Operating Plan MOA at 3, paragraph III.b and III.d.
[135] Operating Plan MOA at 3, paragraph III.b.
[136] Operating Plan MOA at 3, paragraph b.

2. The Mitigation MOA Does Not Correct the Flawed FEIS Mitigation Plan

The many problems with the FEIS mitigation analysis and FEIS mitigation plan are not addressed, resolved, or otherwise corrected by the Mitigation MOA.[137] As a result, the Mitigation MOA does not help ensure that the impacts of the Yazoo Pumps will be mitigated in accordance with the Corps' longstanding mitigation mandates.

The Conservation Organizations appreciate that the MOA re-emphasizes the Corps' statutory mitigation mandates (e.g., the mandates that require a detailed mitigation plan and annual status reports) and explicitly requires EPA concurrence on compensatory mitigation plans before construction begins:

> In all cases, work related to the Project will not commence in waters of the United States until the USACE has obtained concurrence from the EPA on the mitigation plan for each compensatory mitigation component and all in-lieu fee program/mitigation bank credits have been purchased and/or compensatory mitigation sites have been secured.[138]

The Conservation Organizations urge EPA **<u>not</u>** to concur with the FEIS mitigation plan, as that plan is rife with problems as discussed at length in our comments on the DEIS and in these comments on the FEIS. However, the Corps would be free to move forward without EPA concurrence as by its terms, the Mitigation MOA is not binding on any party, is not enforceable, and does not create any actual obligation.[139]

Additional concerns with the Mitigation MOA include: (i) the MOA does not require public notice and comment on proposed mitigation plans; (ii) the MOA does not ensure that the mitigation plan will be reassessed if the operating plan changes, which of course could result in additional significant harm and damage previously chosen mitigation sites; and (iii) the MOA will be reassessed by the agencies (and as a result, could be ended or substantially weakened) decades before the end of Yazoo Pumps' 50-year project life and decades before reforestation efforts could produce fully mature bottomland hardwoods.[140]

/

/

/

/

---

[137] Memorandum of Agreement Between the U.S. Army Corps of Engineers, the U.S. Environmental Protection Agency and the U.S. Fish and Wildlife Service Concerning the Yazoo Backwater Water Management Plan Compensatory Mitigation Plan (November 25, 2024) (hereafter the "Mitigation MOA").

[138] Mitigation MOA at 3-4, paragraph II.c.

[139] Mitigation MOA at 2, paragraph I.c. ("This MOA is not legally binding, does not create any contractual obligation, and is not enforceable by any party. . . . This MOA does not apply to any person outside of the USACE, the EPA and the USFWS.").

[140] Compare Mitigation MOA at 5, Paragraph III ("This MOA will be reviewed by the agencies ten 10 years from the date of award of the first construction contract for the Project.") with FEIS at 166 ("the 50-year project life") and FEIS, Appendix F-6—Aquatic Resources and Fisheries at 11 (referencing 44-year and 54-year timelines for mitigation).

3. The Adaptive Management MOA Highlights Additional Significant Problems with the FEIS

The Conservation Organizations appreciate the development of the Adaptive Management MOA.[141] However, we note that this MOA provides little direction for developing a robust adaptive management plan[142] and is not binding on any party, is not enforceable, and does not create any actual obligation.[143]

Notably, however, the Adaptive Management MOA does acknowledge a number of critical problems with the FEIS. These include the following:

(a) The Adaptive Management MOA acknowledges that the FEIS has not assessed readily available data from "highly refined and accurate satellite-based remote sensing products" that is "critical to informed decision-making."[144] As documented in the MOA:

> The U.S. Army Corps of Engineers engineering models have described the watershed and in-channel hydrology of the system, and potential backwater flooding regimes have been approximated through Geographic Information Systems -based hydrological tools. However, interpolation of watershed-scale hydrology from a limited number of field-based data points can potentially provide an incomplete understanding of watershed hydrology (e.g., wetland saturation and inundation). . . .Complementary remotely sensed data that is continuous in extent will strengthen the understanding of YSA hydrology and is critical to informed decision-making and facts-based adaptive management. This Analysis proposes the use of highly refined and accurate satellite-based remote sensing products (Vanderhoof et al. 2023) to: 1) validate and calibrate estimates of surface water inundation extents of existing USACE hydrology models and tools; 2) leverage field-based measurements of surface-water inundation and soil saturation with remote sensing data via machine learning models to allow for watershed-scale (i.e., beyond individual site) investigation of soil inundation and/or saturation patterns; and 3) facilitate the monitoring of existing conditions of surface water inundation and/or soil saturation, providing real-time responses to both emergent flood-extent determinations and water management decisions.[145]

---

[141] Memorandum of Agreement Between the U.S. Army Corps of Engineers, the U.S. Environmental Protection Agency and the U.S. Fish and Wildlife Service Concerning the Yazoo Backwater Water Management Plan Monitoring and Adaptive Management Plan (November 25, 2024) (hereafter, the "Adaptive Management MOA") at 1-2, paragraph I.c. ("This MOA is not legally binding, does not create any contractual obligation, and is not enforceable by any party. . . . This MOA does not apply to any person outside of the USACE, the EPA and the USFWS.").

[142] The only actual requirement addressed in the MOA is the development of three analyses that "utilize existing baseline data, some of which has been collected for many years in a number of key areas of interest, and at least one additional year of baseline data would be collected prior to Project construction." Adaptive Management Plan MOA at 3, paragraph II.c.

[143] Adaptive Management MOA at 1-2, paragraph I.c. ("This MOA is not legally binding, does not create any contractual obligation, and is not enforceable by any party. . . . This MOA does not apply to any person outside of the USACE, the EPA and the USFWS.")

[144] Adaptive Management MOA at Appendix I, Page 5.

[145] Adaptive Management MOA at Appendix I, Page 5.

(b) The Adaptive Management MOA acknowledges that Alternative 3 could "decrease the duration or frequency of wetland hydroperiods and periods of flood water inundation and soil saturation more than anticipated."[146] This uncertainty is not accounted for in the FEIS or in the proposed mitigation plan.

(c) The Adaptive Management MOA acknowledges that "[p]reliminary hydrologic studies that have been competed in portions of the Yazoo Backwater Study Area" and are relied upon in the FEIS "are not widely representative of wetlands throughout the YSA, nor do they provide robust long-term information about seasonal inundation and saturation."[147]

(d) The Adaptive Management MOA acknowledges that "implementation of the Yazoo Backwater Area Water Management Project could have unintended consequences of further reducing baseflows to headwater streams (i.e., low Strahler stream order) in the YSA by reducing the maximum extent and duration of flood inundation across the landscape, which could contribute to reduced groundwater infiltration."[148] These potential unintended consequences are not discussed in the FEIS.

J. The FEIS Does Not Assess Project Costs and Benefits

The FEIS does not assess project costs and benefits as required by law and does not otherwise address our DEIS comments regarding the items that must be assessed in the benefit-cost analysis. Instead, the FEIS simply acknowledges, as it must, that a benefit-cost analysis has not been included.[149] Accordingly, the comments on the DEIS also apply fully to the FEIS and are incorporated by reference into these comments as though fully set forth herein.

The Conservation Organizations provide the following additional comments regarding the required benefit-cost analysis.

(1) The Conservation Organizations' comments on the DEIS address key costs and benefits that must be assessed in a meaningful analysis of project costs and benefits. We again highlight the critical importance of ensuring that flood damage reduction benefits are not assessed for lands that are currently protected, including federal and state-owned conservation lands and the many acres of privately owned lands enrolled in wetland reserve and other easement programs (see, e.g., the map of Natural Resources Conservation Service Easements in the Yazoo Backwater Area for FY2024 provided at Attachment D to these comments).

(2) The failure to assess project costs and benefits prevents the Corps from being able to meet its long-standing statutory obligation for moving forward with a flood damage reduction project only if "the benefits to whomsoever they may accrue are in excess of the estimated

---

[146] Adaptive Management MOA at Appendix II, Page 7.
[147] Adaptive Management MOA at Appendix II, Page 7.
[148] Adaptive Management MOA at Appendix 3 Page 8.
[149] FEIS response to comment 8 ("Inclusion of a benefit:cost analysis to select an alternative or support a project action was not conducted or included in the DEIS.").

costs, and if the lives and social security of people are otherwise adversely affected."[150] While there are many ways to assess the benefits, an analysis of costs and an analysis of the likely benefits must be carried out.

(3) The FEIS response to comment 499 states in part that "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." As discussed in Section E of these comments, this contradicts—and thus, further undermines—the Corps' historic economic justifications for the Yazoo Pumps and the fundamental purpose of the Yazoo Pumps project. Indeed, for decades, the projected increase in productivity was essential to the Corps' claims regarding the agricultural benefits of the Yazoo Pumps, benefits that dwarfed all others. For example:

- The Alternative 3 operating plan is driven entirely by the desires and interests of industrial scale agricultural producers. Indeed, the operating plan is driven entirely by agricultural (and not flood) seasons with the differing operational levels established for the crop season and non-crop season.

- The 2007 Yazoo Pumps FEIS determined that 80% of project benefits are attributable to agriculture that would result from such things as earlier planting and the adoption of irrigation to improve efficiency.[151]

- The 1982 Yazoo Pumps FEIS determined that the project's primary benefits "would result from an increase in price levels, the increase in pump size, and the increase in agricultural development in the project area since authorization"[152] and noted that "almost all of the flood damages in the area are agricultural."[153] Annual benefits from the 1982 Yazoo Pumps included $15.73 million for agricultural intensification and $3.3 million for reducing flood damages to crops.[154]

- The 1941 authorization for the Yazoo Pumps (which is described in the 1941 Chief of Engineers Report on Flood Control on the Lower Mississippi River[155]) clearly states

[150] 33 U.S.C. § 701a. This requirement was established by the Flood Control Act of 1939 and it applies to all flood damage reduction projects proposed by the Corps, unless Congress has issued a specific project exemption from this requirement (which has not been done for the Yazoo Pumps).
[151] Final Supplement No. 1 to the 1982 Yazoo Area Pump Project Final Environmental Impact Statement (2007)at Page 130-131, Table 26.2007 EIS, Economic Appendix at 7-41 ("All crop benefits result from a reduction of loss of production costs and increased expected net returns resulting from adoption of irrigation and earlier planting dates for the existing cropping pattern. This is possible because the alternatives analyzed reduce the extent, frequency, and duration of flooding, encouraging farmers to plant earlier and allowing them to make investments so they might irrigate later during periods during the growing season when water might be needed.").
[152] USACE, Record of Decision, Yazoo Area Pump Project Reevaluation Report, Yazoo Backwater Area, Yazoo Basin, Mississippi, July 18, 1983.
[153] Yazoo Area Pump Project Reevaluation Report, Volume 2, Technical Report, July 1982 at C-9, Paragraph 34.
[154] Yazoo Pump Project Yazoo Backwater Area Mississippi Reevaluation Report, Appendix F—Economic Analysis at F-10 and Table F-8.
[155] 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).

that the Yazoo Pumps were authorized to facilitate agriculture highlighting that the project was needed because as a result of other large-scale water resources projects, has "lost, to a large extent, such future prospects as otherwise they might have had in agriculture. . . ."[156] As a result, the authorization was limited to providing protection in areas that were considered suitable to agriculture in 1941: "lands inundated more frequently than once in every 5 years are not suited to agriculture and that the land below the 90-foot contour would therefore be dedicated to sump storage."[157] As a result, the authorized Plan C provides: "This plan again 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."[158]

(4) The FEIS response to comment 119 further acknowledges: "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."

While the Corps may, and should, consider non-economic benefits when assessing a project, the Corps must offer a credible analysis demonstrating the "benefits" that the Corps is relying on to justify the project. Where economic benefits will accrue, the Corps must assess those as well and provide a credible demonstration that those economic benefits will in fact accrue. Critically, to assess whether the documented benefits will exceed the project costs (as required by law) the Corps must provide a credible analysis of project costs, which include the costs of mitigation.

In short, to meaningfully assess the Yazoo Pumps Alternative 3—and assess alternatives to that plan, including the Resilience Alternative recommended by the Conservation Organizations and many others—the FEIS must fundamentally reexamine the economic costs and benefits of the Yazoo Pumps. This reexamination is essential in light of the new data, changed conditions, cost increases, significantly larger pumps, and required power source, as highlighted in the Conservation Organizations' comments on the DEIS. This fundamental reevaluation is also critical given the many deficiencies in the last such assessment, which was based on 2005 price levels.[159]

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

[156] Id at 37.
[157] Id. at 40.
[158] Id. at 40.
[159] This analysis was included in the 2007 FSEIS.

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 Alternative 3 which like all derivations of the Yazoo Pumps, would cause unacceptable harm to hemispherically significant wetlands to increase profits for highly subsidized agricultural producers. Alternative 3 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
Audubon Delta

Louie Miller
State Director
Mississippi Chapter of the Sierra Club

Andrew Whitehurst
Water Program Director
Healthy Gulf

Attachment A

Comments on the Final Environmental Impact Statement for the Yazoo Backwater Area Water Management Project, November 2024

Submitted by

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

December 30, 2024

NATIONAL WILDLIFE FEDERATION | Audubon | SIERRA CLUB MISSISSIPPI CHAPTER | Audubon DELTA | healthy gulf

November 5, 2024

Via Email
Bruno Pigott
Acting Assistant Administrator for Water
U.S. Environmental Protection Agency
1201 Constitution Ave NW
Washington, DC 20004

Re: Time-Sensitive: Newly Obtained Documents Further Substantiate that the 2024 Yazoo Backwater Pumping Plant Draft EIS (DEIS) Significantly Underestimates Adverse Impacts to Fish and Wildlife

Dear Acting Assistant Administrator Pigott:

Our organizations appreciate our continued dialogue with your office regarding the Yazoo Backwater Pumping Plant and your agency's longstanding commitment to protecting the Yazoo Backwater Area's vital wetlands. Our organizations recently received documents that reveal additional significant flaws[1] in the U.S. Army Corps of Engineers' (Corps) analysis of the project and we are writing to share that information with you. These documents, which were provided to our organizations in late October[2], further substantiate that the DEIS significantly underestimates the project's adverse impacts to an extensive array of fish and wildlife species and relies on flawed methodologies explicitly rejected by your agency's 2008 Clean Water Act veto.[3]

[1] The many additional ways in which the DEIS underestimates impacts are discussed in detail in the August 27, 2024, comments on the DEIS submitted by our organizations (Conservation Organizations 2024 DEIS Comments).
[2] These documents were provided by the Corps' Engineer Research and Development Center on October 27, 2024, in response to a Freedom of Information Act request submitted on June 28, 2024. A copy of the documents discussed in this letter is provided with this letter and can be accessed at https://waterprotectionnetwork.org/wp-content/uploads/2024/11/EnviroFish_Calculations-August-2024.xlsx.
[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); November 17, 2021, Letter from EPA Assistant Administrator Radhika Fox to Acting Assistant Secretary of the Army (Civil Works), Jamie Pinkham.

EnviroFish Model Input and Output Data

The documents provided by the Corps show that the agency failed to assess a wide array of impacts to the fish, shorebirds, and wading birds that rely on the vital wetlands in the Yazoo Backwater Area (YBWA). **Specifically, the documents show that the Corps improperly constrained its EnviroFish model and as a result failed to assess impacts to fish, shorebirds, and wading birds that will occur above the 1-year floodplain and failed to assess all impacts to these species within the 1-year floodplain.** This flawed approach to assessing impacts is extremely problematic, including because **all** spawning and rearing habitat above the 2-year floodplain will be lost through operation of the Yazoo Pumps which will prevent water levels from rising above the 2-year floodplain throughout the entire spawning and rearing season.

The Corps used the EnviroFish model to determine the maximum, minimum, and mean habitat elevations for fish breeding and rearing in the YBWA, and to model the impacts of the Yazoo Pumps to that identified habitat. In response to our Freedom of Information Act request, the Corps provided the input data used to parameterize the EnviroFish model and the output data from that model.

As the Corps explained in its modeling notes, the Corps relied solely on September water levels to parameterize its EnviroFish model: "The output used the Sept RAS daily stage".[4] In other words, the Corps used September stage levels to determine the maximum and minimum habitat elevations for fish breeding and rearing, and for modeling impacts to that habitat from the Yazoo Pumps.

Critically, however, the use of September stage data alone does not—and cannot—accurately represent stage levels during the spawning and rearing season in the YBWA. As an initial matter, fish **do not** spawn or rear in September in the YBWA; fish spawn and rear from March through June. As a result, there is no justification from a biological perspective to use September stage data to assess the pumps' impacts on spawning and rearing. September stage levels also cannot serve as a surrogate for stage levels during the spawning and rearing season because September is one of the driest months of the year in the YBWA (resulting in stage levels that are at or near the lowest yearly levels). Moreover, the extremely low September stage levels are not relevant to operation of the Yazoo Pumps as the Yazoo Pumps would never have operated in September over the period of record analyzed by the Corps.[5]

Because the EnviroFish model is parameterized with extremely low and unrepresentative September stage data, the model's maximum and minimum habitat elevation outputs are also extremely low and unrepresentative of stage levels during the spawning and rearing season. This can be seen by comparing the EnviroFish output data with the Corps' contemporaneously collected stage gage levels which are available at RiverGages.com. For example, the EnviroFish model shows the maximum elevation during the spawning and rearing season as 87.91 feet at Steele Bayou (landside).[6] This elevation is **below** the 2-year and 5-year floodplain elevations,[7] which provide habitat for spawning and

---

[4] USACE EnviroFish Calculations August 2024 at Notes Tab.
[5] The Yazoo Pumps would never have been operated in September over the period of record examined in the DEIS. DEIS, Appendix A, Engineering Report at 135, Table 2-31.
[6] USACE EnviroFish Calculations August 2024 at Summary Tab.
[7] DEIS, Appendix A, Engineering Report at 124-125.

rearing as stated in the DEIS and the Corps' HGM Regional Guidebook.[8] However, the Corps' RiverGages readings show that water elevations exceeded—and often greatly exceeded—87.91 feet during the breeding and rearing season during **28 years** over the period of record[9], as depicted in Figure 1.

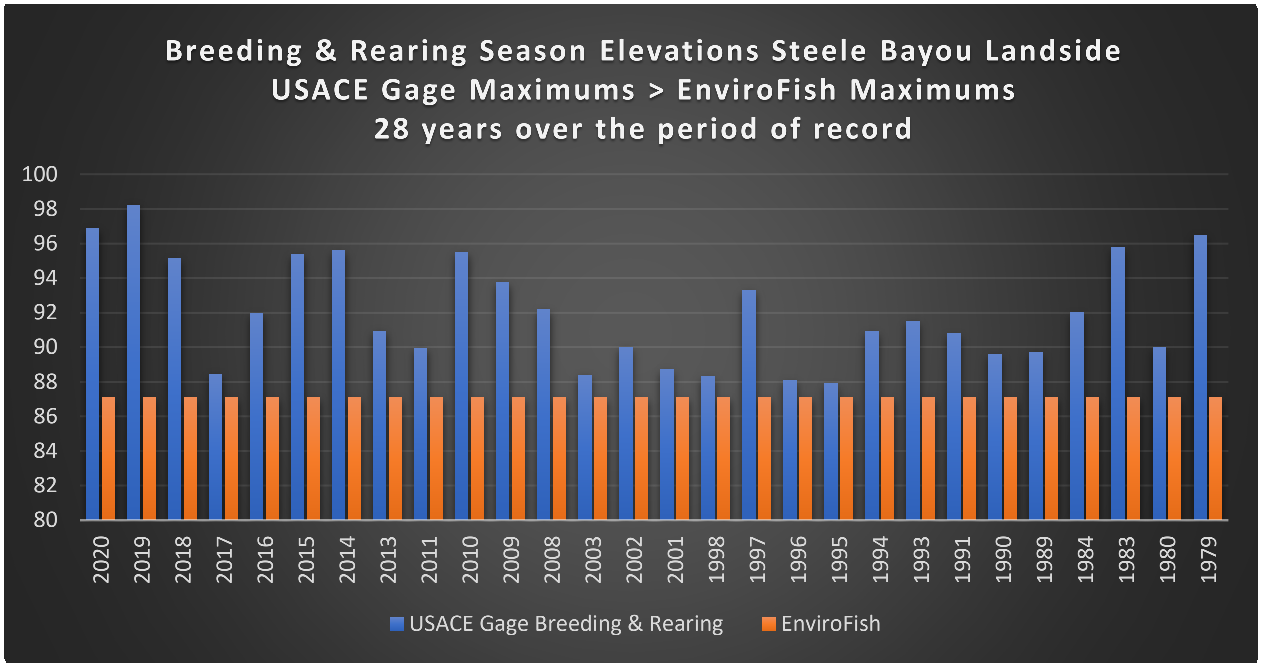


Figure 1: Breeding & Rearing Season Elevations at Steele Bayou, USACE Gage Maximums vs EnviroFish Maximums

The Corps then compounds its already significant underestimates of maximum habitat elevations by relying on the much lower average (mean) of the maximum and minimum elevations as the baseline for assessing the Yazoo Pumps' impacts to fish, shorebirds, and wading birds. According to the model outputs, the mean elevation for spawning and rearing habitat at Steele Bayou (landside gage) is 81 feet.[10] This is **8.3 to 9.6 feet below the elevation of the 2-year floodplain**, depending on the "series" used by the Corps.

[8] 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).
[9] Data obtained from the USACE RiverGages.com website.
[10] USACE EnviroFish Output Data at Summary Tab (EnviroFish Summary by Season and Gage - 2023 Study).

Indeed, the EnviroFish mean elevation is **below** the 1-year floodplain at all gage stations, as established by the "Partial Series" which the DEIS has used to assess the amount of fisheries mitigation[11], as shown in Figure 2 below.

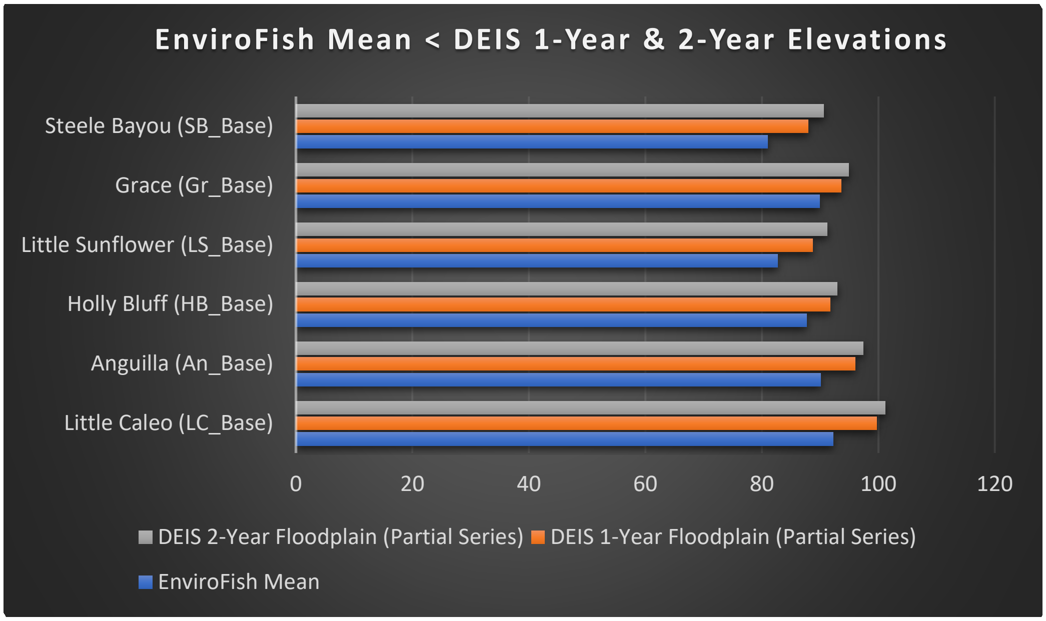


Figure 2: EnviroFish Mean Elevations vs. DEIS 1-Year & 2-Year Floodplain Elevations (Partial Series)

The DEIS then further compounds these errors, including by failing to assess and account for the loss of 14 consecutive days of overbank flooding as directed by the Clean Water Act veto[12], by assessing fisheries impacts based on the entire period of record instead of assessing habitat losses that would occur during periods of higher water elevations when the pumps would be operating, and by relying on averages of averages that further masks impacts.[13]

The flawed outputs from the EnviroFish model also taint the DEIS analysis of shorebird and wading bird impacts because the EnviroFish model outputs formed the foundation of the shorebird and wading bird models.[14] As extensively documented in our organizations' comments on the DEIS, the shorebird and wading bird impact assessments also suffer from many other highly significant flaws.[15]

Conclusion

As discussed with you and your staff, the Corps' own assessment demonstrates that the latest Yazoo Pumps proposal violates the project's longstanding Clean Water Act veto—including by damaging more than 90,000 acres of hemispherically significant wetlands and pumping water below the 91-foot elevation "during the critical spawning and rearing months."[16] As also discussed, the DEIS significantly

---

[11] DEIS, Appendix A, Engineering Report at 124-125.
[12] Clean Water Act veto, Fisheries Technical Appendix at 17.
[13] Conservation Organizations 2024 DEIS Comments at 53-60.
[14] DEIS, Appendix F-4 at 5.
[15] Conservation Organizations 2024 DEIS Comments Cite at 43-48.
[16] Clean Water Act veto at 56.

understates the unacceptable impacts of this damage on hundreds of species of fish and wildlife that rely on the YBWA wetlands—a conclusion that is further substantiated by the significant flaws discussed in this letter. Please do not hesitate to reach out to Melissa Samet (sametm@nwf.org, 415-762-8264) if you have any questions or require additional information on these issues.

Our organizations greatly appreciate your agency's longstanding commitment to protecting the Yazoo Backwater Area's hemispherically significant wetlands and we urge you to ensure continued protection by enforcing the longstanding Clean Water Act veto of the Yazoo Pumps.

Sincerely,

Melissa Samet
Legal Director, Water Resources and Coasts
National Wildlife Federation

Brian Moore
Vice-President, Coast Policy
National Audubon Society

Louie Miller
State Director
Mississippi Chapter of the Sierra Club

Jill Mastrototaro
Mississippi Policy Director
Audubon Delta

Andrew Whitehurst
Water Program Director
Healthy Gulf

cc:
Jaime Pinkham, Acting Assistant Secretary of the Army (Civil Works)
Robyn Colosimo, Deputy Assistant Secretary of the Army (Project Planning and Review)
Daffny Pitchford, U.S. Fish and Wildlife Service, Deputy Regional Director Southeast Region
YazooBackwater@usace.army.mil

Attachment B

Comments on the Final Environmental Impact Statement for the Yazoo Backwater Area Water Management Project, November 2024

Submitted by

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

December 30, 2024

JOURNAL OF THE AMERICAN WATER RESOURCES ASSOCIATION

Vol. 46, No. 2 AMERICAN WATER RESOURCES ASSOCIATION April 2010

ECOLOGICALLY FUNCTIONAL FLOODPLAINS: CONNECTIVITY, FLOW REGIME, AND SCALE[1]

Jeffrey J. Opperman, Ryan Luster, Bruce A. McKenney, Michael Roberts, and Amanda Wrona Meadows[2]

ABSTRACT: This paper proposes a conceptual model that captures key attributes of ecologically functional floodplains, encompassing three basic elements: (1) hydrologic connectivity between the river and the floodplain, (2) a variable hydrograph that reflects seasonal precipitation patterns and retains a range of both high and low flow events, and (3) sufficient spatial scale to encompass dynamic processes and for floodplain benefits to accrue to a meaningful level. Although floodplains support high levels of biodiversity and some of the most productive ecosystems on Earth, they are also among the most converted and threatened ecosystems and therefore have recently become the focus of conservation and restoration programs across the United States and globally. These efforts seek to conserve or restore complex, highly variable ecosystems and often must simultaneously address both land and water management. Thus, such efforts must overcome considerable scientific, technical, and socioeconomic challenges. In addition to proposing a scientific conceptual model, this paper also includes three case studies that illustrate methods for addressing these technical and socioeconomic challenges within projects that seek to promote ecologically functional floodplains through river-floodplain reconnection and/or restoration of key components of hydrological variability.

(KEY TERMS: aquatic ecology; ecosystem services; flooding; fluvial processes; restoration; riparian ecology; wetlands.)

Opperman, Jeffrey J., Ryan Luster, Bruce A. McKenney, Michael Roberts, and Amanda Wrona Meadows, 2010. Ecologically Functional Floodplains: Connectivity, Flow Regime, and Scale. *Journal of the American Water Resources Association* (JAWRA) 46(2):211-226. DOI: 10.1111/j.1752-1688.2010.00426.x

INTRODUCTION

Riverine floodplains support high levels of biodiversity and some of the most productive ecosystems on Earth. They are also extremely valuable economically in terms of the services they provide to society, including reduction of flood risk and support for highly productive fisheries (Costanza *et al.*, 1997). Despite their considerable environmental and economic benefits, temperate-region floodplains have been extensively disconnected from rivers and converted to land uses such as agriculture. Although large expanses of hydrologically connected floodplains remain in late-developing regions of Africa, Asia, and Latin America, these systems face increasing

[1]Paper No. JAWRA-09-0040-P of the *Journal of the American Water Resources Association* (JAWRA). Received February 21, 2009; accepted January 6, 2010. **Discussions are open until six months from print publication**.

[2]Respectively, Senior Advisor for Sustainable Hydropower, The Nature Conservancy, 91 Carriage Stone Drive, Chagrin Falls, Ohio 44022 and Research Associate, Center for Watershed Sciences, University of California, Davis, California; Restoration Program Manager, The Nature Conservancy, Chico, California; Senior Economic Advisor, The Nature Conservancy, Charlottesville, Virginia; Director, Government and Agency Relations, The Nature Conservancy, Salt Lake City, Utah; and Director, Savannah River Project, The Nature Conservancy, Savannah, Georgia (E-Mail/Opperman: jopperman@tnc.org).

pressure from land-use change and infrastructure development (Tockner and Stanford, 2002).

Recent research has highlighted both the values of floodplains and their loss and continued vulnerability (Tockner and Stanford, 2002). This increased attention has led to considerable expansion of efforts to restore and protect floodplains (Rohde *et al.*, 2006). Due to the complexity and variability of these ecosystems, and because floodplain conservation often requires addressing both land use and water management, the conservation of ecologically functional floodplains poses considerable scientific, technical, and socioeconomic challenges. This paper strives to distill the scientific complexities through a conceptual model and then provides case studies that illustrate approaches for addressing the technical and socioeconomic challenges.

The conceptual model emphasizes three primary elements necessary for the restoration or conservation of a functional floodplain ecosystem: hydrological connectivity between the river and floodplain, a variable flow regime that incorporates a range of flow levels, and sufficient geographic scale for key processes to occur and for benefits to accrue to a meaningful level. To illustrate how floodplain conservation must simultaneously address these primary scientific elements and overcome socioeconomic and technical constraints, we provide case studies of three projects where The Nature Conservancy (TNC) is restoring functional floodplain ecosystems. These projects address issues of connectivity, flow regime, and spatial scale with varying approaches including collaborations with water managers, the development of markets for ecosystem services, and linking floodplain restoration with flood-damage reduction.

FLOODPLAIN ECOSYSTEMS: PRODUCTIVITY, DIVERSITY, VALUES, AND THREATS

Although numerous definitions exist (Nanson and Croke, 1992), a floodplain can be broadly defined as a landscape feature that is periodically inundated by water from an adjacent river. In this paper, we focus primarily on lowland floodplains that are generally associated with low gradient rivers within broad alluvial valleys. Here, we emphasize floodplains as geomorphic features – formed and influenced by river flows and sediment – upon which ecosystems develop and operate.

Floodplain ecosystems support high levels of biodiversity and levels of primary productivity that generally exceed the production of either purely terrestrial or aquatic ecosystems (Tockner and Stanford, 2002). Floodplain diversity and productivity can both be attributed to dynamic and variable connectivity with river flows: the periodic inundation by flood waters is largely responsible for high floodplain productivity (Junk *et al.*, 1989) whereas high-energy flows induce erosion and deposition, resulting in habitat heterogeneity and, consequently, high levels of biodiversity (Salo *et al.*, 1986).

During periods of inundation, floodplains provide very different habitat conditions than found in the adjacent river channel. As flow moves from the river onto the floodplain water velocity generally slows considerably, allowing sediment to drop out of suspension. As a result, floodplain water is often less turbid than river water and can thus support greater rates of photosynthesis from aquatic vascular plants and algae (including both attached algae and phytoplankton) (Ahearn *et al.*, 2006). This primary productivity in turn supports high productivity of zooplankton and aquatic invertebrates (Junk *et al.*, 1989; Grosholz and Gallo, 2006).

River organisms such as fish can enter floodplains during high flows and gain access to the high productivity of floodplain habitats (Figure 1). Further, the low-velocity, shallow, and vegetated habitats of the floodplain serve as a refuge from the fast, turbid waters of the river during high flows (Sommer *et al.*, 2001b). Many fish species time their spawning to coincide with flooding so that their offspring can rear

FIGURE 1. Floodplain Productivity Benefits Fish. Juvenile Chinook salmon reared in experimental enclosures on the Cosumnes River (California) floodplain (on right) had significantly faster growth rates than those reared in enclosures on the main-stem river (on left). Photograph by Jeff Opperman; research described in Jeffres *et al.* (2008).

within food-rich and sheltered floodplain habitats (Welcomme, 1979). As a result of the increased productivity available to fish, rivers with connected floodplains and an unaltered flood pulse generally have a higher yield of fish per area than do rivers lacking a flood pulse, known as the "flood pulse advantage" (Bayley, 1991). Consequently, floodplain rivers support the largest freshwater fisheries in the world (discussed further below; Welcomme, 1979).

The floodplain aquatic productivity described above is driven by long-duration and frequent flood pulses (Junk *et al.*, 1989). Other key floodplain characteristics, such as riparian forests, are influenced by a different type of flooding: high magnitude, and thus less frequent, floods with sufficient energy to drive geomorphic processes (Whiting, 1998). Infrequent large floods build and rework floodplain surfaces, eroding sediment and vegetation in some areas and depositing sediment in other areas. Channels can shift during large floods, resulting in the creation of new features such as side channels and oxbow lakes created by meander cutoffs (Knighton, 1998). Floodplains that are connected to dynamic river regimes undergo periodic disturbance that creates topographic heterogeneity. Floodplain surfaces with small differences in elevation and soil type can have considerable differences in hydroperiod and disturbance regime (Naiman *et al.*, 2005). Thus, topographic heterogeneity and connectivity with dynamic flows result in a floodplain with a shifting mosaic of diverse habitat patches, in terms of species, age classes, and physical structure (Ward *et al.*, 2002). The development of floodplain (riparian) forest is strongly influenced by the availability of appropriate sediment substrate and hydrological conditions, driven by river flow patterns and geomorphic processes (Mahoney and Rood, 1998; Richter and Richter, 2000; Rood *et al.*, 2003).

Due to this productivity and habitat heterogeneity, floodplains support high levels of biodiversity (Salo *et al.*, 1986; Tockner and Stanford, 2002). Floodplains also support high levels of ecosystem services (Gren *et al.*, 1995; Opperman *et al.*, 2009) – products and processes produced by functioning ecosystems that economically benefit society (Brauman *et al.*, 2007). In their review of the value of the world's ecosystem services, Costanza *et al.* (1997) found that floodplains were the second ranked ecosystem type, behind only estuaries, in terms of their per-hectare value to society. Despite representing <2% of Earth's terrestrial land surface area, floodplains provided approximately 25% of all "terrestrial" (i.e., nonmarine) ecosystem service benefits, with regulation of disturbance (i.e., attenuation of flood flows) providing the most value (e.g., see Akanbi *et al.*, 1999). Other floodplain ecosystem services include filtration of surface water (Mitsch *et al.*, 2001; Noe and Hupp, 2005), groundwater recharge (Jolly, 1996), recreation (Gren *et al.*, 1995), and provision of protein (e.g., fish) and fiber (e.g., timber and other plant resources) (Welcomme, 1979). Fisheries supported by floodplain productivity provide one of the most tangible examples of an economically and socially valuable ecosystem service. The Mekong River, which retains an unregulated flood pulse and extensive hydrologically connected floodplains, supports the largest freshwater fishery in the world, providing a primary source of protein to 60-70 million people in Southeast Asia (Mekong River Commission, 2005; Baran *et al.*, 2007). The commercial fisheries of temperate river floodplains – such as those on the Illinois and Missouri Rivers – have disappeared or are greatly diminished, due in large part to the disconnection of rivers from productive floodplain habitats (Galat *et al.*, 1998).

Despite floodplains' immense ecological and economic values, they have been disconnected from river flows and converted to other land uses in much of the world. For example, <10% of historic floodplain habitat in California remains (Barbour *et al.*, 1991) and floodplain forests on the Mississippi River below the confluence of the Ohio River have declined by 80% from their historic extent (Llewellyn *et al.*, 1995). Levees prevent river flows from entering floodplains (Tobin, 1995), whereas dams can greatly alter the magnitude, frequency, and duration of floods and thus the interaction between rivers and floodplains (Magilligan and Nislow, 2005) (Figure 2). Intact floodplains remain along large rivers in late-developing regions of Africa, Asia, and Latin America. However, these floodplains are vulnerable to changing land-use patterns, such as the expansion of cities and agriculture, and by flow regulation from rapidly proliferating dams (Dudgeon, 2000). In their review of the current and future status of floodplains, Tockner and Stanford (2002) note that "in the near future, floodplains will remain among the most threatened (ecosystems), and they will disappear faster than any other wetland type."

A CONCEPTUAL MODEL FOR FLOODPLAIN RESTORATION AND CONSERVATION

The recent research summarized above highlights both the values of, and threats to, floodplains. Consequently, considerable resources are now being directed to floodplain conservation and restoration (Bernhardt *et al.*, 2005; Rohde *et al.*, 2006). Here, we describe a conceptual model that attempts to capture the complex interactions and processes that structure ecologically functional floodplains (Figure 3). The conceptual

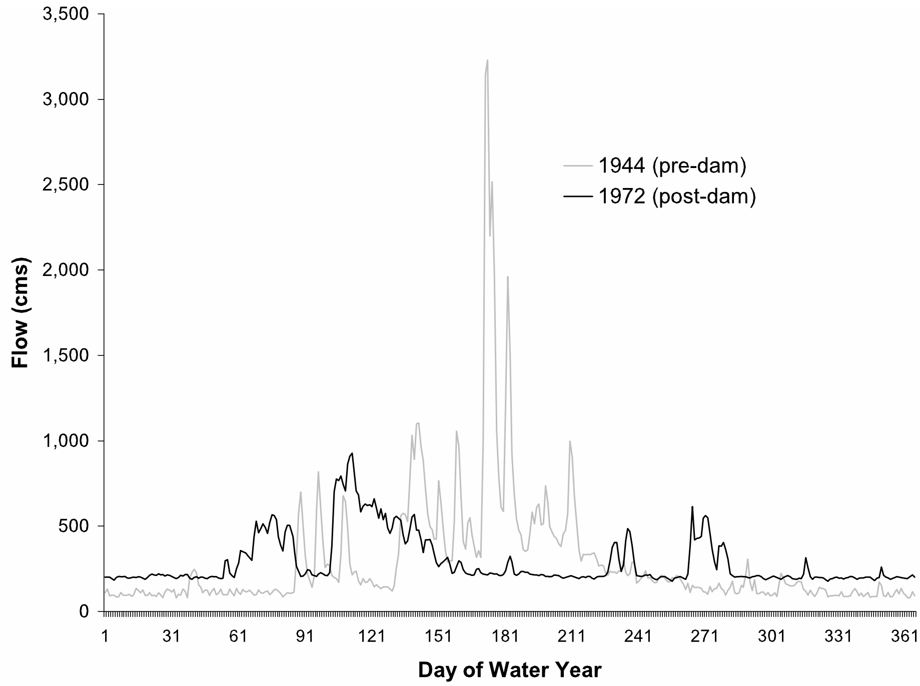


FIGURE 2. Pre-dam (1944; gray line) and Post-dam (1972; black line) Hydrographs for the Savannah River at Augusta, Georgia, Below Thurmond Dam. The two years had nearly identical mean annual flow.

model's basic premise is that ecologically functional floodplains require three primary elements.

1. *Connectivity*. A functional floodplain must be connected with its adjacent river to allow the exchange of flow, sediment, nutrients, and organisms (Amoros and Bornette, 2002).
2. *Flow regime*. Floodplain ecosystems are created, maintained, and influenced by a wide variety of flow levels and events, ranging from extreme low flows to infrequent high flows (Poff *et al.*, 1997; Whiting, 2002). Therefore, an ecologically functional floodplain requires interaction with a river that retains a flow regime with sufficient variability to encompass the flow levels and events that support important floodplain processes.
3. *Spatial scale*. A functional floodplain requires a minimum geographic extent for two reasons. First, the floodplain must encompass sufficient spatial scale to allow important dynamic processes to occur, such as erosion and deposition during large floods (Richards *et al.*, 2002; Rohde *et al.*, 2005). Second, the floodplain (by itself or with other associated floodplain sites) must encompass sufficient spatial scale for benefits to accrue to a meaningful level (e.g., for management purposes).

The primary elements of the model and Figure 3 are sufficiently general so as to apply to a broad range of lowland, low-gradient river floodplains, with the exception of the box "Extended inundation of various patch types." This box illustrates the linkages between the *timing* of flood events and biological processes and in this figure reflects floodplain processes within California's Central Valley; the specific timing of biological processes, such as fish spawning, will vary from system to system. This conceptual model synthesizes elements from a broad range of concepts and studies that describe various floodplain processes and functions. The most well-known conceptual model, the Flood Pulse Concept (FPC) (Junk *et al.*, 1989) posited that large rivers and floodplains should be viewed as interacting components of a single system. Although the FPC paper (Junk *et al.*, 1989) and its update (Junk and Wantzen, 2004) and extensions (e.g., Tockner *et al.*, 2000) acknowledge the role of erosive floods in creating floodplain topography, they focus primarily on processes and interactions that take place during periods of floodplain inundation and draining. A different set of studies and concepts – in the fields of geomorphology and riparian and landscape ecology – focus on the interactions between river flows and floodplain topography (Whiting, 1998; Florsheim and Mount, 2002; Larsen *et al.*, 2006) and how vegetative communities develop on heterogeneous floodplain topography, influenced by flow and disturbance regimes over time (Mahoney and Rood, 1998; Ward, 1998; Greco and Plant, 2003). These studies

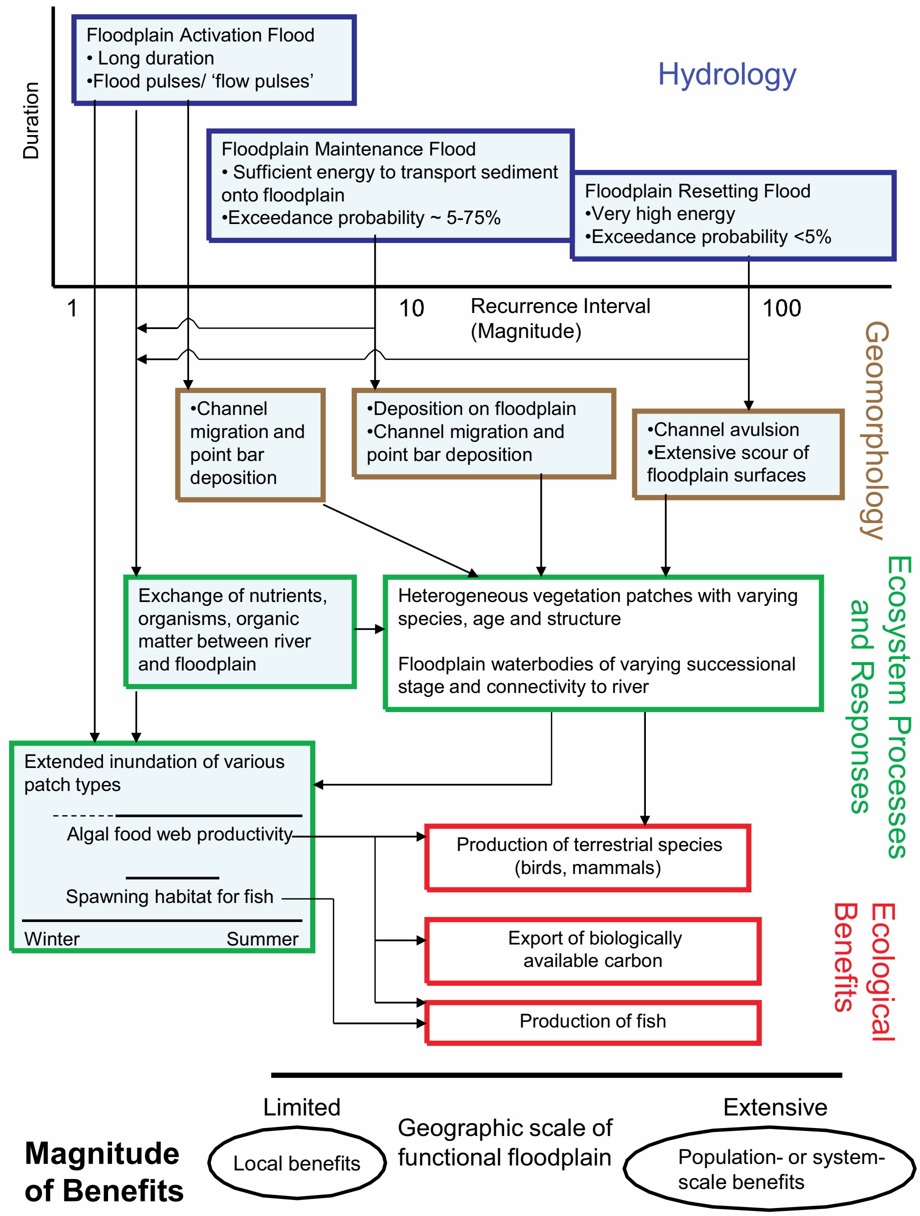


FIGURE 3. A Conceptual Model of Floodplain Processes in California's Central Valley. Blue-shaded boxes indicate processes that occur during the period of inundation. Note the temporal scale bar (Winter → Summer) in the box "Extended inundation of various patch types," which indicates that the occurrence and magnitude of ecosystem processes vary with the season of inundation.

generally do not examine the ecological processes that occur *during* periods of inundation.

In this conceptual model, we emphasize that floodplains are valued by society for both the processes that occur during periods of inundation, such as fisheries productivity, as well as those processes that occur over longer time periods, such as the development of riparian forest communities on floodplain landforms. Further, these various processes interact: short-term flood events shape and maintain floodplain topography and vegetation; the processes that occur during subsequent inundations, such as the development of aquatic food webs, occur within this evolving template of floodplain topography and ecosystems. Thus, this conceptual model seeks to encompass a broad range of flows, ranging from below bankfull flow pulses to very rare high-magnitude events, and various ecological processes that occur over time periods ranging from weeks to years to decades.

A diverse range of flows influence floodplain geomorphic and ecological processes (Trush *et al.*, 2000; Whiting, 2002) and numerous aspects of these flows have geomorphic and ecological significance, including magnitude, frequency, duration, rates of change, and seasonality (Poff *et al.*, 1997), as well as antecedent conditions on the floodplain. To simplify, this conceptual model focuses on three types of "representative floods," characterized by their frequency and magnitude (and, in the case of the floodplain activation flood, duration, and seasonality). These representative floods are simplifications of a much broader spectrum of flow types and events and can also be viewed as management targets that can be expressed as "building blocks" (*sensu* King and Louw, 1998) or Environmental Flow Components (EFC) (Richter *et al.*, 2006; Mathews and Richter, 2007; see also the Savannah River case study below).

The model (Figure 3) is organized into five main areas: at the top, the *Hydrology* portion of the model (blue-outlined boxes) depicts the representative floods, arrayed along axes for frequency/magnitude and duration. These floods perform geomorphic work, described in the brown-outline boxes in the *Geomorphology* portion of the model. Hydrologic and geomorphic processes create the conditions for *Ecosystem Processes and Responses* to occur (green-outlined boxes). In the model, blue-shaded boxes indicate processes that occur during the period of inundation. The non-shaded *Ecosystem* box encompasses ecological processes that occur over longer periods of time (e.g., decades), such as the development of riparian vegetation. This box necessarily simplifies these complex processes. The objective here is to simply depict the linkages between flows, geomorphic processes, and heterogeneous floodplain communities; numerous sources describe in detail the establishment and development of riparian vegetation (Mahoney and Rood, 1998; Rood *et al.*, 2003, 2005; Stella *et al.*, 2006). The Ecosystem Processes and Responses produce *Ecological Benefits* (red-outlined boxes), and the *Magnitude of Benefits* varies with the geographic scale of the functional floodplain (see scale bar along bottom of figure). Note that the *Ecological Benefits* listed in the figure are only a subset of those that could be identified. Three representative floods are described below.

Floodplain Activation Flood

The floodplain activation flood is a small-magnitude flood that occurs relatively frequently and can be further defined in terms of seasonality and duration (Figure 4) – for example, Williams *et al.* (2009) defined a floodplain activation flood for California's Central Valley as an inundation that lasts at least one week and occurs in the spring with a recurrence interval of two out of three years. A long-duration flood produces characteristic ecological benefits such as habitat for native fish spawning and rearing (Figure 1) and food-web productivity (Figure 4b). The duration of the flood is important as these processes cannot occur during a short event. The seasonality of the flood also influences which ecological processes occur and their magnitude [see the temporal scale bar (Winter → Summer) in one of the ecological process boxes]. For example, floodplain productivity is much greater when long-duration flooding occurs during periods of warmer temperatures and abundant sunshine (Schramm and Eggelton, 2006; Sheibley *et al.*, 2006). Note that floodplain activation floods can be temporally coincident with other representative floods. For example, a floodplain activation flood can occur during the recession limb of a higher-magnitude event such as a floodplain maintenance flood (Figure 4a). Floodplain activation floods support many of the processes ascribed to overbank flow pulses in the FPC (Junk *et al.*, 1989). Here, we suggest that the floodplain activation flood should be defined with greater specificity in terms of hydrological characteristics (e.g., duration, frequency, season) – linked to desired ecological outputs (e.g., food-web productivity) – than a more generic flood pulse. In complex channels, long-duration below-bankfull flow pulses (*sensu* Tockner *et al.*, 2000) that inundate bars, side channels, and other features of complex channels can also support many of the processes associated with a floodplain activation flood (Williams *et al.*, 2009).

Floodplain Maintenance Flood

The floodplain maintenance flood is a higher magnitude flood (Figure 4a) capable of performing geomorphic work including bank erosion and deposition on the floodplain that creates and maintains floodplain surfaces and contributes to heterogeneous floodplain topography (Whiting, 1998; Florsheim and Mount, 2002) (Figure 3). In turn, this heterogeneous topography results in vegetation patches of varying age, species composition, and structure (Figures 4c and 4d), and floodplain waterbodies of varying successional stage and connectivity to the river (Ward *et al.*, 2002). As expressed by flow-duration curves, floodplain maintenance floods occur relatively infrequently. However, the recurrence interval of this flood type varies based on river gradient, elevation difference between the channel and floodplain, sediment supply, and connectivity (Florsheim and Mount, 2002) and can range from every year to less frequently. A floodplain maintenance flood can be estimated by an analysis of the dominant processes that are responsible for creating floodplain surfaces (Whiting, 1998), such as vertical accretion (overbank deposition) or lateral accretion (meander migration

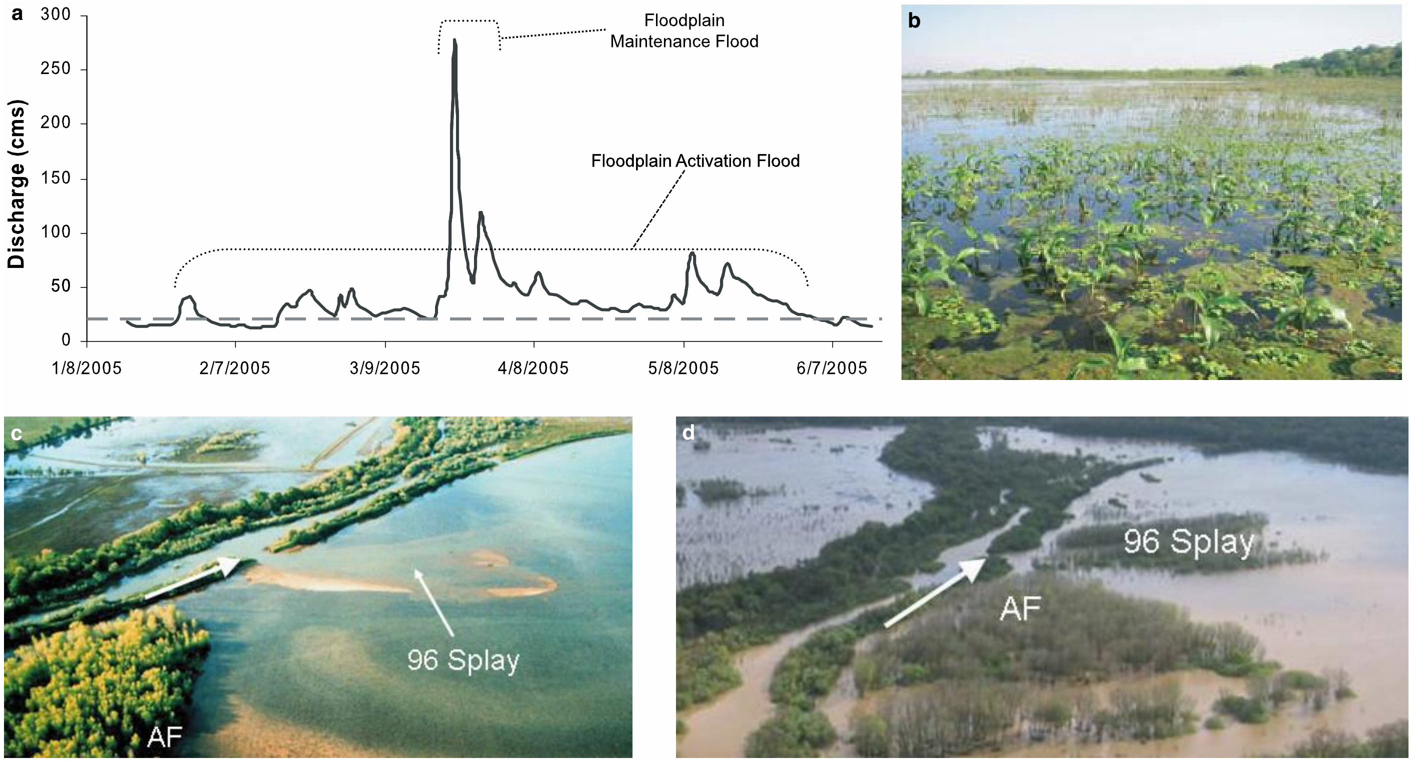


FIGURE 4. Representative Floods on the Cosumnes River Floodplain. (a) Hydrograph from the Cosumnes River (California), winter and spring 2005. The horizontal dashed line indicates the approximate discharge (20 cms) at which the river and floodplain are connected. (b) A floodplain activation flood on the Cosumnes River floodplain, April 2005. Note the relative clarity of the water (i.e., low turbidity) and the development of algal mats in the water and on the emergent vegetation (Photo by Jeff Opperman) (c) A crevasse sand splay was formed due to sediment transport and deposition during a floodplain maintenance flood in 1996 following an intentional levee breach in 1995 (described in detail in Florsheim and Mount, 2002). The white arrow indicates the direction of flow in the channel and points to the levee breach. "AF" indicates the "accidental forest," a stand of riparian trees that regenerated on a sand splay deposited during an unintentional levee breach in 1985 (Photo by Mike Eaton). (d) The inundated floodplain in 2006 (the white arrow again indicates the direction of flow and points to the 1995 levee breach). Riparian trees have preferentially established on the sediment deposits of the 1996 sand splay (shown after initial formation in c). "AF" again indicates the accidental forest (Photo by Mike Eaton).

and point bar deposition) (Nanson and Croke, 1992; Knighton, 1998). Whiting (1998) reported that the floodplain maintenance flood for the East Branch of the Chagrin River (Ohio) – a flood with sufficient depth and energy to deposit fine sediment onto the floodplain – had a recurrence interval of four years. At the Cosumnes River floodplain (California), flows capable of depositing sand on the floodplain corresponded to a 1.5-year recurrence interval (Booth *et al.*, 2006; Florsheim *et al.*, 2006). Richter and Richter (2000) estimated that the mosaic of floodplain forest along the Yampa River (Colorado) could be maintained provided that sufficient meander migration occurred over time to rework floodplain surfaces and initiate vegetative succession. They suggested that flows with a magnitude ≥125% of bankfull discharge, maintained for at least 15 days, were critical for maintaining sufficient meander migration and lateral accretion to support healthy floodplain forests over time. This observation emphasizes that duration, in addition to magnitude, can also be important for the geomorphic processes associated with a floodplain maintenance flood.

Floodplain Resetting Floods

Floodplain resetting floods are very high-magnitude and relatively rare events (e.g., exceedance probability <5%) that result in extensive geomorphic changes, including scouring of floodplain surfaces and changes in channel location due to avulsion (Nanson, 1986; Wohl, 2000). Although there is no clear-cut distinction between floodplain maintenance floods and resetting floods, the key feature of floodplain resetting flows is that they produce sufficient shear stresses to cause extensive scour of floodplain surfaces and can potentially result in abrupt changes in channel location (Trush *et al.*, 2000). The ecosystem processes associated with a floodplain activation flood occur within the mosaic of habitat features created during floodplain maintenance floods and floodplain resetting floods.

Application of model to Central Valley

To expand on these basic concepts and illustrate the conceptual model, we provide an example of floodplain processes from California's Central Valley. The conceptual model could be similarly elaborated and refined for other lowland, low-gradient river-floodplain systems.

Floodplains in the Central Valley have been reduced dramatically from their historical extent due to flow regulation from dams, levees and rip-rap, and channelization and channel incision (Katibah, 1984). This loss of floodplains has contributed to the decline of numerous species in the Valley's rivers and riparian forests as well as in the downstream Sacramento-San Joaquin Delta ("the Delta"). State and federal agencies have numerous policies and programs dedicated to reversing these declines. In the following, we describe three important ecological benefits that the restoration actions seek to promote. Note that here (Figure 3) the primary outputs of the model are "ecological benefits" – by which we mean desired outcomes of environmental management and restoration programs – and the model does not reflect broader ecosystem services such as flood attenuation or groundwater recharge. The conceptual model could be adapted to include such ecosystem services as outputs.

Food-Web Productivity. Central Valley floodplains can produce high levels of phytoplankton and other algae, particularly during long-duration flooding that occurs in the spring (Sommer *et al.*, 2004; Ahearn *et al.*, 2006). Downstream of Central Valley floodplains, the Delta contains several fish species with declining populations, such as the Delta smelt (*Hypomesus transpacificus*), and food limitation is likely one of the factors contributing to these declines (Jassby and Cloern, 2000). Algae provide the most important food source for zooplankton in the Delta (Muller-Solger *et al.*, 2002) and these zooplankton are a primary food source for numerous Delta fish species. Consequently, a potential benefit of floodplain restoration is an increase in the productivity of food webs that support Delta fish species (Ahearn *et al.*, 2006).

Spawning and Rearing Habitat for Native Fish. Recent research has demonstrated that floodplains provide the necessary spawning habitat for the Sacramento splittail (*Pogonichthys macrolepidotus*), an endemic minnow. Splittail can be considered "obligate floodplain spawners," meaning they require inundated floodplain habitat to spawn. Recruitment of splittail is strongly correlated with the duration of floodplain inundation (Sommer *et al.*, 1997). Recent studies have also revealed that juvenile Chinook salmon (*Oncorhynchus tshawytscha*) have faster growth rates on floodplains than in main-stem river channels (Sommer *et al.*, 2001b; Jeffres *et al.*, 2008). Juvenile Chinook can enter and rear on floodplains during their downstream migrations in the winter and early to mid-spring. The juveniles have access to a diverse and dense prey base on floodplains – zooplankton density can be 10-100 times greater in a floodplain compared with the river (Grosholz and Gallo, 2006) – along with generally more favorable habitat conditions (warmer, slower water, fewer predators). These conditions translate to faster growth compared with juveniles rearing in rivers (Figure 1). Faster growth rates allow juveniles to attain larger sizes when they enter the estuary and ocean, and body size has been found to be positively associated with survival to adulthood for salmonids (Unwin, 1997).

Riparian Habitat Structure. Floodplain maintenance and floodplain resetting floods erode banks and deposit sediment, creating the necessary conditions for the regeneration of riparian tree species (Richter and Richter, 2000; Trush *et al.*, 2000). In the Central Valley, tree species such as cottonwood (*Populus fremontii*) time their seed release to coincide with the historic peak of snowmelt runoff because these high flows create the necessary conditions – such as the deposition of alluvial soil – for successful germination, growth, and survival of seedlings (Stella *et al.*, 2006). Riparian forests support high levels of biodiversity and provide essential habitat to a number of endangered species, including the Valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*), the yellow-billed cuckoo (*Coccyzus americanus*), and many other birds (Golet *et al.*, 2008).

The model illustrates the importance of hydrological variability and connectivity for an ecologically functional floodplain. For example, a floodplain that rarely is inundated by a floodplain activation flood will not produce the ecological benefits of food-web productivity or spawning and rearing habitat for native fish. A floodplain that is not subject to floodplain maintenance floods or floodplain resetting floods will not maintain the mosaic of habitats (e.g., vegetation and water bodies of varying successional stages) that help support floodplain biodiversity (Amoros, 1991; Tockner and Schiemer, 1997; Ward *et al.*, 2001). Along the bottom of the Figure 3, the scale bar indicates that a small floodplain site will only produce local benefits, whereas extensive floodplains will produce benefits that are measurable at a population or system scale.

Recent research in the Central Valley illuminates how issues of connectivity, flow regime, and scale influence the functionality of Central Valley floodplains. For example, the Cosumnes River is the only major river entering the Central Valley that lacks major dams and flow regulation. Consequently, the Cosumnes River retains a natural hydrograph encompassing a broad range of flow levels (Figure 4). TNC acquired lowland floodplain habitat along the Cosumnes River and began planting riparian trees on former agricultural land. However, the floodplain was still disconnected from the river by a remnant levee and widespread natural regeneration of riparian trees did not occur until an accidental breach in the levee reinitiated dynamic connectivity between river and floodplain. High-energy flows through the breach deposited sediment and created topographic heterogeneity, which lead to the regeneration of a stand of riparian trees, named the "accidental forest" (Figures 4c and 4d) (Swenson *et al.*, 2003).

Due to the successful riparian regeneration from the accidental breach, TNC intentionally breached the levee in several additional locations. With the increased connectivity, floodplain maintenance floods occur relatively frequently, with flows with a recurrence interval of one to two years capable of inducing heterogenous topography on the floodplain (Florsheim and Mount, 2002). In addition to promoting geomorphic processes and riparian regeneration, the restored connectivity allows floodplain activation floods to occur, with the associated key processes of splittail spawning, juvenile Chinook rearing (Figure 1), and food-web productivity (Figure 4b) (Ahearn *et al.*, 2006; Moyle *et al.*, 2007).

Williams *et al.* (2009) recently explored the effect of altered flow regimes on the functionality of floodplains along the Sacramento River. They found that due to channel incision and regulation from upstream reservoirs, floodplain activation floods (defined in their study as floods that last at least one week in the spring) have been greatly reduced compared with pre-dam conditions. Currently, the production of benefits associated with these floods – food-web productivity and native-fish habitat – are mostly restricted to the Yolo Bypass, a large (24,000 ha) engineered flood bypass that conveys overflow from the Sacramento River (Sommer *et al.*, 2001a). Thus, due to the alteration of the flow regime, even areas that are hydrologically connected to the Sacramento River during larger magnitude floods have a much lower frequency of inundation by long duration spring floods than occurred historically, limiting their ability to provide this important component of a functional floodplain.

Finally, the two floodplain areas described above – the Cosumnes River floodplain and the Yolo Bypass – differ dramatically in scale, with the Cosumnes encompassing approximately 40 ha of frequently inundated floodplain compared with the bypass's 24,000 ha. Although the Cosumnes can provide local benefits for splittail and Chinook salmon, the Yolo Bypass can influence fish at the population scale. For example, the duration of inundation of the Yolo Bypass is a strong predictor of year-class strength for splittail for the entire system (Central Valley and Delta; Sommer *et al.*, 1997).

ADDRESSING CONNECTIVITY, FLOW REGIME, AND SCALE THROUGH RESTORATION PROJECTS

The conceptual model presented here outlines the challenges confronting floodplain conservation: to protect or restore a functional floodplain, the project must encompass both flow regime and connectivity and thus must address both land use and water management. Further, for the project or program to produce meaningful benefits, it must achieve its results at a sufficiently large spatial scale. Therefore, beyond addressing the scientific complexities of conserving a functional floodplain, floodplain restoration confronts significant technical and socioeconomic challenges (Opperman *et al.*, 2009).

In the following, we provide three case studies where TNC and its partners are working to restore flow regimes and/or connectivity with strategies that can affect a large spatial scale. These case studies also illustrate approaches to overcoming socioeconomic constraints to floodplain restoration through the use of a variety of strategies including collaboration with water management agencies (Savannah River), developing markets for ecosystem services (Mollicy Farms), and linking floodplain restoration with a flood-damage reduction project (Hamilton City). Thus, even though the environmental outcomes of these projects may not be apparent for years, the cases represent important advances in overcoming institutional and socioeconomic challenges to large-scale floodplain restoration.

The Savannah River (Georgia)

The Savannah River watershed contains extremely high species biodiversity, including the greatest number of native fish species (approximately 100) of any United States (U.S.) river draining into the Atlantic (Meyer *et al.*, 2003). However, the river's flow regime and longitudinal connectivity are heavily impacted by dams. The U.S. Army Corps of Engineers (the Corps) maintains three large dams on the upper Savannah

River, creating Hartwell, Russell, and Thurmond reservoirs. Thurmond Dam (1954) was the first built and is located the furthest downstream, just upstream of the city of Augusta. The dams are operated for multiple purposes, including flood control, water supply (for over 1.5 million people), hydropower, and recreation. The river forms the border of Georgia and South Carolina and empties into the Atlantic through an extensive estuary surrounding the city of Savannah.

Regulation from the dams has greatly altered the flow regime of the Savannah River (Figure 2). For example, the current estimate for the 100-year flow is roughly equivalent to the pre-dam 2-year flow [2,550 cubic meters per second (cms)]. The current two-year flow (approximately 991 cms) is one-third the size of the pre-dam two-year flow. Because of this flow regulation, interactions between the river and floodplain have changed greatly. Although the flow regime has been altered, the potential to restore high magnitude events (such as floodplain maintenance and floodplain resetting flows) persists because more than 68,000 ha of floodplain forest between the dams and the estuary remain undeveloped and unleveed (Meadows *et al.*, 2007).

Numerous fish species of southeastern rivers use lowland floodplains during periods of inundation (Ross and Baker, 1983) and the reproductive success of many species within the piscine families cyprinidae (e.g., common carps and various shiners), centrarchidae (e.g., sunfish and bass), and percidae (e.g., various darters) have been correlated with the extent, timing, and duration of floodplain inundation along southeastern rivers (Killgore and Baker, 1996). A literature review conducted in support of the restoration process described below concluded that between ¼ and ½ of the fish species found in the Savannah River likely use inundated floodplain habitats for spawning and approximately 85% of all the river's fish species likely use floodplain habitats for refuge and foraging (Meyer *et al.*, 2003). Thus, scientists hypothesized that restoring portions of the historic hydrograph to promote river-floodplain connectivity will benefit a high proportion of the Savannah River's fish species.

In 2002, TNC and the Corps began a collaborative effort to investigate the potential to release environmental flows from Thurmond Dam, as part of a national partnership (the Sustainable Rivers Project) to restore ecological integrity to rivers affected by Corps dams (Warner, 2007). Within a workshop setting, teams of scientists and water managers developed environmental flow recommendations for the river, floodplain, and estuary ecosystems. Flow recommendations were framed as the EFC of low flows, high-flow pulses, and floods (*sensu* Mathews and Richter, 2007) and defined in terms of magnitude, frequency, duration, season, and rates of change. Each EFC was expressed in the form of a hypothesis describing the expected linkages between flow and specific biological or physical processes (e.g., fish migration or river-floodplain connectivity). These hypotheses lay the foundation for monitoring and adaptive management to refine the flow recommendations (Richter *et al.*, 2006; Warner, 2007).

Following the workshop, the Corps has begun to implement portions of the flow recommendation, with four experimental high-flow pulses released over three years. Scientific staff from resources agencies, TNC, and academia are now monitoring the river to investigate the effects of the experimental flow releases. The monitoring program includes long-term response variables to measure ecosystem response (e.g., tree regeneration), and "trigger" variables that can give more immediate guidance to flow implementation (e.g., spawning movements of fish).

The Savannah River case (and the Sustainable Rivers Project more broadly) illustrates the potential gains in flow regime restoration that can be accomplished through collaboration with water managers (Warner, 2007). The monitoring program is building a foundation for scientists to refine flow recommendations and reduce uncertainties. The experimental flow releases provide an opportunity for scientists and water managers to communicate and for both to gain experience with implementing and studying environmental flows. Initial monitoring results were used to inform subsequent high-flow pulse releases.

Although large areas of the Savannah River floodplain are within public ownership such as wildlife refuges (16,000 ha in Georgia; 33,000 ha in South Carolina), future flow releases to inundate the floodplain could be constrained by even relatively small changes in floodplain land use that are incompatible with flooding (e.g., agriculture or residential development). To ensure that river-floodplain connectivity remains possible, TNC has organized a consortium of resource agencies, conservation organizations, and private landowners to create The Savannah River Preserve, a corridor of protected lands along both sides of the river encompassing a range of habitats – wetland forests, estuaries, streams, and adjacent uplands. To date, 66 private landowners – representing 100,000 ha of rural lands – have agreed in principle to sell their development rights at a discount value to help create the preserve. Maintaining this large, landscape-scale floodplain intact will remain a challenge but, if successful, The Savannah River Preserve will allow the Corps to release sufficiently high flows to connect the river to its biologically rich floodplain.

Mollicy Farms (Ouachita River, Louisiana)

Covering about 10 million ha (25 million acres), the Lower Mississippi River Alluvial Valley was once one of the great floodplain forests on Earth. But from the mid-1800s to late-1900s, most of the forest was cleared for timber and replaced by intensive row-crop agriculture. Today <3 million ha of bottomland forest remain (King and Keeland, 1999). Initially, clearing occurred on lands at higher elevations with well-drained soils but, with time, farmers began to clear and cultivate lower elevation lands that were prone to flooding and thus had lower potential agricultural productivity. Despite flood engineering structures, these low-lying agricultural lands are inundated every few years and major floods still threaten the region.

The Nature Conservancy is exploring an ecosystem services strategy for restoring bottomland hardwood forests to these lands as a viable alternative to marginal row-crop agriculture. The foundation for this strategy expands beyond the biodiversity benefits of floodplains and includes the full portfolio of ecosystem services they deliver. These services include carbon sequestration to mitigate climate change, recreation such as duck hunting and fishing, flood attenuation to reduce downstream flood risks, and nutrient removal to improve water quality and reduce contributions to the Gulf of Mexico's "dead zone" (Mitsch *et al.*, 2001). In some cases, floodplain reconnection may also reduce future levee maintenance costs.

To investigate the feasibility of this strategy, TNC is working with the U.S. Fish and Wildlife Service, U.S. Geological Survey, and other partners to implement floodplain reconnection and restoration at Mollicy Farms, a 6,400 ha site that was cleared for soybean agriculture in the 1960s. Located within the Upper Ouachita National Wildlife Refuge along the Ouachita River in Morehouse Parish, Louisiana, Mollicy Farms and the surrounding area already attract hundreds of thousands of migrating waterfowl each fall and winter. The restoration project will include reconnecting the floodplain to the river through levee breaches and restoring former agricultural land to wetland and forest. Scientists predict that these actions will greatly increase the diversity of habitat types and range of ecosystem services provided by the site.

As the site of the largest floodplain reconnection and bottomland afforestation project in the U.S., Mollicy Farms provides a valuable opportunity to study large-scale floodplain restoration and the associated ecosystem service benefits. A research program will examine the site's ecosystem services, with the following primary research questions: How much does floodplain restoration change the production of services? From the time of project initiation, how does the generation of these service benefits increase/change over time? How does scale affect benefits such as flood attenuation? What is the value of service improvements to society (social welfare value), and what is the potential private market value if a landowner were to sell services?

To support market development for these services, TNC will be conducting long-term monitoring at Mollicy Farms, as well as at control sites, to understand how services of restored floodplains change over time. For services, the focus is on carbon sequestration, nutrient removal and water quality, recreation, and flood attenuation. A study of ecosystem service values in the Mississippi Alluvial Valley indicates significant wetland service values, and the potential for future market values of services to exceed net income from agriculture (Table 1) (Murray *et al.*, 2009). Much will depend on how existing voluntary carbon markets (e.g., Chicago Climate Exchange) evolve under expected future regulation, and the extent to which markets for other services such as nutrient removal emerge.

Because it may be many years before the extent of service improvements at the site are fully understood, TNC plans to develop preliminary estimates of service benefits that can be refined over time based on monitoring data and changes in markets. By increasing the understanding about floodplain service benefits through a large-scale demonstration project, TNC seeks to inform and strengthen strategies for advancing floodplain restoration at meaningful spatial scales.

Hamilton City (Sacramento River, California)

The Nature Conservancy and several conservation partners formed the Sacramento River Project in 1988 to pursue large-scale, process-based restoration of riparian and floodplain habitats of the Sacramento River (Golet *et al.*, 2006, 2008). To date, the project has conserved approximately 5,400 ha of riparian habitat along the Sacramento River, between the towns of Colusa and Red Bluff (Figure 5). Primary strategies include the conservation of flood-prone land through acquisition or easement, active riparian restoration (i.e., planting), and the restoration of natural river processes (Golet *et al.*, 2008). Initial results suggested that, due to the altered hydrology of the Sacramento River, irrigation was necessary for successful riparian restoration (Alpert *et al.*, 1999). Golet *et al.* (2008) reported that restored riparian sites supported a broad range of fauna, including birds, bats, and insects.

TABLE 1. Ecosystem Service Values of Restoring Agricultural Lands to Bottomland Hardwood Forest Wetlands in the Lower Mississippi Alluvial Valley, Compared With the Net Income From Agriculture ($/hectare/year).

Ecosystem Services	Social Welfare Value	Private Market Value	
		Current	Potential
Greenhouse gas mitigation	$162-$213	$59	$419
Nitrogen mitigation	$1,268	$0	$634
Wildlife recreation	$16	$15	$15
Flood attenuation and other services	?	?	?
Total	$1,446-$1,497+	$74+	$1,068+
Agricultural net income		$368	

Notes: Question marks in the row for "flood attenuation" indicate that Murray *et al.* (2009) did not attempt to quantify these values as they are strongly influenced by location and total size of a floodplain site. The flood attenuation values of connected floodplains can be quite high (Akanbi *et al.*, 1999; Opperman *et al.*, 2009). Source: Murray *et al.* (2009).

Within this context of large-scale riparian restoration, the Sacramento River Project's scope expanded to encompass the integration of floodplain reconnection and flood risk management. The Hamilton City Ecosystem Restoration and Flood Damage Reduction Project was one of the first projects to utilize new Army Corps policy guidelines intended to promote multipurpose projects (e.g., projects that combine ecosystem restoration with flood-damage reduction). This case study examines the partnership and policy components that were keys to advancing a multipurpose project at Hamilton City. Because the multipurpose guidelines were new, this project confronted numerous policy challenges. Although some policy hurdles remain (discussed below), the project has provided a forum for resolving policy constraints that will benefit future multipurpose projects.

Hamilton City is located on the Sacramento River approximately 130 km north of Sacramento in Glenn County, California (Figure 5). The population of 2,500 and the surrounding agricultural lands receive marginal flood protection by an old (circa 1904) degraded private levee called the "J" levee. The J levee only offers protection against a 10-year flood and, as a result, Hamilton City has been evacuated due to flooding concerns six times in the last 25 years.

Over that time period, citizens of Hamilton City made several attempts to secure a project that would reduce flood risk. Although the Army Corps conducted various project feasibility studies, none produced a project alternative capable of meeting a positive cost-benefit ratio. In 2001, the Corps introduced new planning policies that created an opportunity for the town. These new policies facilitate a combination of project goals such as flood damage reduction and ecosystem restoration. Hamilton City formed a collaborative partnership to study a combined project alternative. The collaboration included a broad range of stakeholders, including Reclamation District 2140, the Hamilton City Community Services District, Citizens in Action, Glenn County, local agricultural interests, the Corps, the State Reclamation Board, the California Department of Water Resources, the California Bay-Delta Authority, and TNC (Golet *et al.*, 2006). The studies resulted in the first project alternative in over 20 years that met requirements for federal participation and funding.

A key to reaching this first successful project alternative was the inclusion of ecosystem benefits, specifically those benefits arising from river-floodplain connectivity. The project benefits arising from only riparian revegetation (e.g., through planting and irrigation and without reconnection) would have been insufficient to justify the project. Instead, the successful project formulation featured the removal of the degraded "J" levee and building 11 km of setback levee up to 1.6 km away from the river channel, thus creating 600 ha of reconnected habitat (Figure 5). The setback levee will provide the critical environmental benefits of river-floodplain connection across a range of flow levels, including high-energy flows capable of reworking floodplain sediment and creating diverse habitat patches (i.e., floodplain maintenance flows). The reconnected area will be sufficiently large to allow these dynamic processes to occur.

Flood protection for both Hamilton City and the surrounding agricultural lands are greatly increased by the recommended plan. The setback levee will provide the town with protection from a 75-year recurrence interval flood (compared with the town's current level of protection from a 10-year flood) and surrounding agricultural lands, which previously flooded very frequently (<5 year protection), will benefit from a training dike that will both reduce the frequency of inundation and, when flooding occurs, prevent harmful scouring.

The Hamilton City case study illustrates the potential for large-scale floodplain restoration to occur through multipurpose flood-damage reduction projects. More broadly, the case study highlights the need for continued policy reforms to encourage and facilitate such multipurpose projects. The initial policy changes allowing Corps projects to combine project purposes resulted in a plan for Hamilton City that received broad support, met multiple objectives, and therefore utilized a variety of funding sources (e.g., federal flood-damage reduction and state-federal ecosystem restoration funding). However, securing additional funding for the project has posed challenges, highlighting the need for additional policy changes. Current policy for ranking and prioritizing

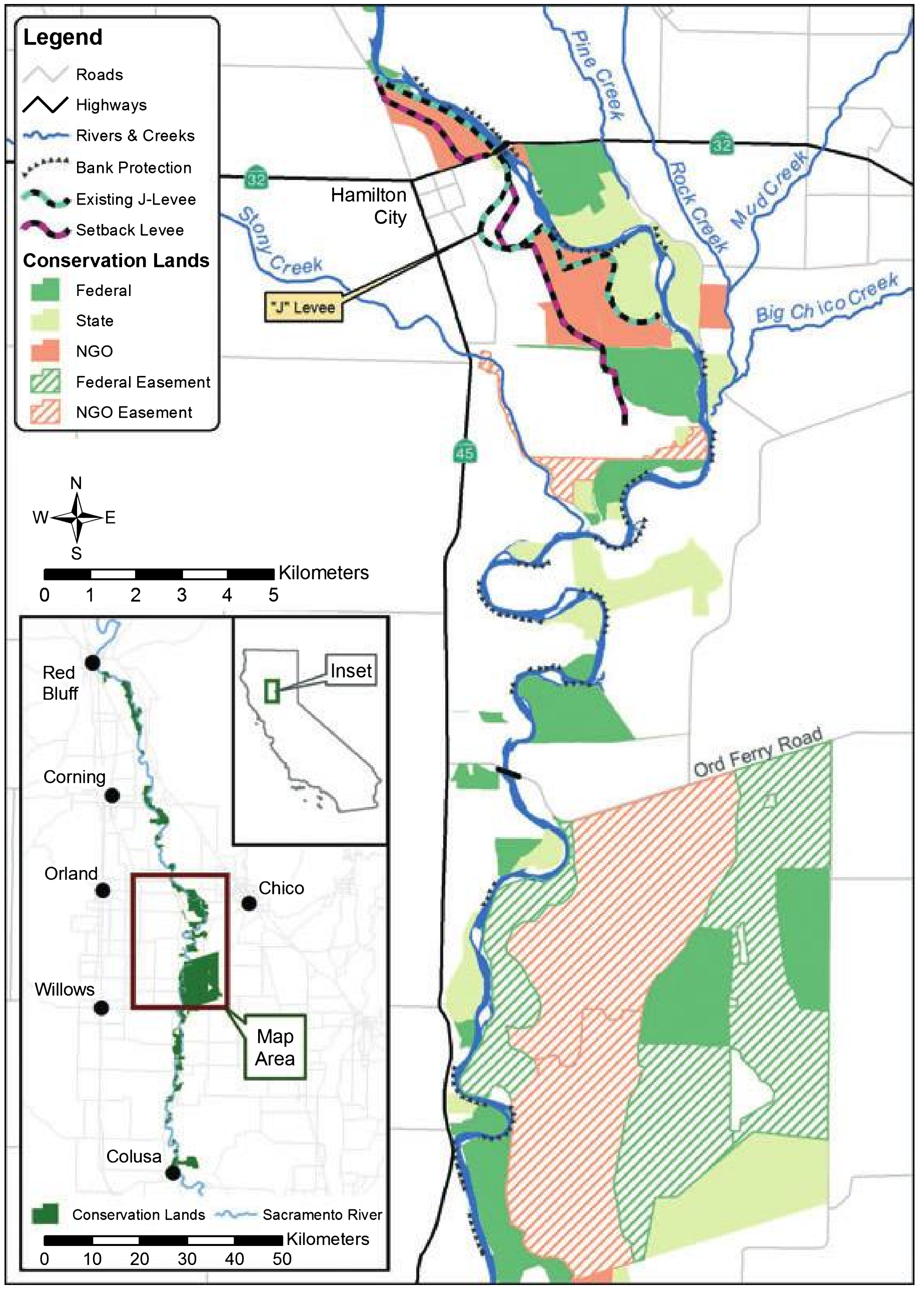


FIGURE 5. Location of the Hamilton City Ecosystem Restoration and Flood Damage Reduction Project. The project features the construction of a setback levee to replace the degraded “J” levee and to reconnect 600 ha of floodplain with the Sacramento River. The inset map shows the full spatial scale of riparian and floodplain conservation sites as part of the Sacramento River Project.

Corps projects for funding requires projects to be evaluated based on a single purpose and thus multipurpose projects must be evaluated on the strength of one of their purposes. Multipurpose projects such as Hamilton City would greatly benefit from a new system that ranked projects based on their full range of benefits.

Lastly, projects at the scale of the Hamilton City Project, embedded within the larger Sacramento River Project (thousands of hectares and >1 km in floodplain width), create the opportunity to implement flow regime management strategies. TNC is currently exploring opportunities to restore key components of the natural hydrograph to the Sacramento River. As a first step, TNC developed the Sacramento River Ecological Flows Project that reviewed existing information, integrated numerous models and field data, and created a software-based decision analysis framework. The analysis framework can compare life-history responses of several species – including cottonwood and Chinook salmon – to alternative flow management strategies.

CONCLUSIONS

Floodplains are complex, productive ecosystems that support high levels of biodiversity and provide important ecosystem services to society. An ecologically functional floodplain requires connectivity to a river with a flow regime with sufficient variability to include a range of flow levels and events, such as the floodplain activation flood and floodplain maintenance flood described in this conceptual model.

This conceptual model is intended to guide restoration projects so that they consider the broad range of flows required to support functional floodplains. For example, using hydraulic models, a proposed floodplain reconnection project can be evaluated in terms of which types of floods will inundate various portions of the project site. For a levee setback project on the Bear River (California), planners determined that none of the project area would be inundated by floodplain activation floods (as defined by Williams *et al.*, 2009) and thus a portion of the project area was graded to an elevation that would allow inundation by this type of flood (Williams *et al.* 2009).

The specific representative floods described in this model can provide preliminary examples for "building blocks" or EFCs for restoring or maintaining floodplain functions (see the Savannah case study). The representative floods described in this model must be refined – in terms of duration, frequency, magnitude, season – for the specific system as well as the specific functions and processes that managers seek to support. For example, floodplain maintenance floods will vary based on the dominant process for building floodplain surfaces (e.g., lateral versus vertical accretion). Finally, the representative floods described here are not an exhaustive description of important characteristics of the flow regime. Specific sequences of flood events can influence floodplain processes (Ahearn *et al.*, 2006) and groundwater levels beneath the floodplain are influenced by river stage, with important implications for riparian vegetation (Mahoney and Rood, 1998).

Conserving floodplains across large geographic areas remains a primary challenge for floodplain restoration projects and programs. The case studies in this paper illustrate various approaches for achieving floodplain restoration at large spatial scales, ranging from hundreds of hectares (Hamilton City) to tens of thousands of hectares (Savannah). The Savannah River Project demonstrates that environmental flow releases for floodplain inundation can be achieved through collaboration between conservation organizations, water managers, and other stakeholders. Additionally, the Savannah River Project highlights the linkages between flow regime and land use for floodplain conservation as the Savannah River Preserve strives to maintain land uses compatible with floodplain inundation. The significant ecosystem services associated with floodplains may provide a financial mechanism for implementing floodplain conservation at large spatial scales, as is being explored at Mollicy Farms. Finally, Hamilton City demonstrates that multipurpose flood-damage reduction projects can achieve large-scale floodplain restoration. Projects that integrate floodplain restoration and a primary floodplain ecosystem service – reduction of flood risk – will likely become increasingly important in a future where changes in climate and land-use patterns lead to increased flood risk.

ACKNOWLEDGMENTS

Valuable contributions to the development of the conceptual model, and its application to the Central Valley, were provided by E. Andrews, S. Bozkurt, P. Moyle, M. Tompkins, and P. Williams.

LITERATURE CITED

Ahearn, D.S., J.H. Viers, J.F. Mount, and R.A. Dahlgren, 2006. Priming the Productivity Pump: Flood Pulse Driven Trends in Suspended Algal Biomass Distribution Across a Restored Floodplain. Freshwater Biology 51:1417-1433.

Akanbi, A.A., Y. Lian, and T.W. Soong, 1999. An Analysis on Managed Flood Storage Options for Selected Levees Along the Lower Illinois River for Enhancing Flood Protection. Report No. 4: Flood Storage Reservoirs and Flooding on the Lower Illinois River, Illinois State Water Survey Contract Report 645, Champaign, Illinois.

Alpert, P., F.T. Griggs, and D.R. Peterson, 1999. Riparian Forest Restoration Along Large Rivers: Initial Results From the Sacramento River Project. Restoration Ecology 7:360-368.

Amoros, C., 1991. Changes in Side-Arm Connectivity and Implications for River System Management. Rivers 2:105-112.

Amoros, C. and G. Bornette, 2002. Connectivity and Biocomplexity in Waterbodies of Riverine Floodplains. Freshwater Biology 47:761-776.

Baran, E., T. Jantunen, and C.K. Chong, 2007. Value of Inland Fisheries in the Mekong River Basin. *In:* Tropical River Fisheries Valuation: Background Papers to a Global Synthesis, A.E. Neiland and C. Bene (Editors). World Fish Centre, Phnom Penh, Cambodia, pp. 227-290.

Barbour, M., B. Pavlik, F. Drysdale, and S. Lindstrom, 1991. California Vegetation: Diversity and Change. Fremontia 19:3-12.

Bayley, P.B., 1991. The Flood Pulse Advantage and the Restoration of River-Floodplain Systems. Regulated Rivers: Research and Management 6:75-86.

Bernhardt, E.S., M.A. Palmer, J.D. Allan, G. Alexander, K. Barnas, S. Brooks, J. Carr, S. Clayton, C. Dahm, J. Follstad-Shah, D. Galat, S. Gloss, P. Goodwin, D. Hart, B. Hassett, R. Jenkinson, S. Katz, G.M. Kondolf, P.S. Lake, R. Lave, J.L. Meyer, T.K. O'Donnell, L. Pagano, B. Powell, and E. Sudduth, 2005. Synthesizing US River Restoration Efforts. Science 308:636-637.

Booth, E.G., J.F. Mount, and J.H. Viers, 2006. Hydrologic Variability of the Cosumnes River Floodplain. San Francisco Estuary and Watershed Science 4:Article 2.

Brauman, K.A., G.C. Daily, T.K. Duarte, and H.A. Mooney, 2007. The Nature and Value of Ecosystem Services: An Overview Highlighting Hydrologic Services. Annual Review of Environment and Resources 32:67-98.

Costanza, R., R. d'Arge, R. de Groot, S. Farber, M. Grasso, B. Hannon, K. Limburg, S. Naeem, R.V. Oneill, J. Paruelo, R.G. Raskin, P. Sutton, and M. van den Belt, 1997. The Value of the World's Ecosystem Services and Natural Capital. Nature 387:253-260.

Dudgeon, D., 2000. Large-Scale Hydrological Changes in Tropical Asia: Prospects for Riverine Biodiversity. BioScience 50:793-806.

Florsheim, J.L. and J.F. Mount, 2002. Restoration of Floodplain Topography by Sand-Splay Complex Formation in Response to Intentional Levee Breaches, Lower Cosumnes River, California. Geomorphology 44:67-94.

Florsheim, J.L., J.F. Mount, and C.R. Constantine, 2006. A Geomorphic Monitoring and Adaptive Assessment Framework to Assess the Effect of Lowland Floodplain River Restoration on Channel-Floodplain Sediment Continuity. River Research and Applications 22:353-375.

Galat, D.L., L.H. Fredrickson, D.D. Humburg, K.J. Bataille, J.R. Bodie, J. Dohrenwend, G.T. Gelwicks, J.E. Havel, D.L. Helmers, J.B. Hooker, J.R. Jones, M.F. Knowlton, J. Kubisiak, J. Mazourek, A.C. McColpin, R.B. Renken, and R.D. Semlitsch, 1998. Flooding to Restore Connectivity of Regulated, Large-River Wetlands – Natural and Controlled Flooding as Complementary Processes Along the Lower Missouri River. BioScience 48:721-733.

Golet, G.H., T. Gardali, C.A. Howell, J. Hunt, R.A. Luster, W. Rainey, M.D. Roberts, J. Silveira, H. Swagerty, and N. Williams, 2008. Wildlife Response to Riparian Restoration on the Sacramento River. San Francisco Estuary and Watershed Science 6:Article 1.

Golet, G.H., M.D. Roberts, R.A. Luster, G. Werner, E.W. Larsen, R. Unger, and G.G. White, 2006. Assessing Societal Impacts When Planning Restoration of Large Alluvial Rivers: A Case Study of the Sacramento River Project, California. Environmental Management 37:862-879.

Greco, S.E. and R.E. Plant, 2003. Temporal Mapping of Riparian Landscape Change on the Sacramento River, Miles 196-218, California, USA. Landscape Research 28:405-426.

Gren, I.M., K.H. Groth, and M. Sylven, 1995. Economic Values of Danube Floodplains. Journal of Environmental Management 45:333-345.

Grosholz, E. and E. Gallo, 2006. The Influence of Flood Cycle and Fish Predation on Invertebrate Production on a Restored California Floodplain. Hydrobiologia 568:91-109.

Jassby, A.D. and J.E. Cloern, 2000. Organic Matter Sources and Rehabilitation of the Sacramento – San Joaquin Delta (California, USA). Aquatic Conservation: Marine and Freshwater Ecosystems 10:323-352.

Jeffres, C.A., J.J. Opperman, and P.B. Moyle, 2008. Ephemeral Floodplain Habitats Provide Best Growth Conditions for Juvenile Chinook Salmon in a California River. Environmental Biology of Fishes 83:449-458.

Jolly, I.D., 1996. The Effects of River Management on the Hydrology and Hydroecology of Arid and Semi-Arid Floodplains. *In:* Floodplain Processes, M.G. Anderson, D.E. Walling, and P.D. Bates (Editors). John Wiley & Sons Ltd., New York, pp. 577-609.

Junk, W.J., P.B. Bayley, and R.E. Sparks, 1989. The Flood Pulse Concept in River Floodplain Systems. *In:* Proceedings of the International Large River Symposium (LARS), D.P. Dodge (Editor), Canadian Special Publication of Fisheries and Aquatic Science 106:110-127.

Junk, W.J. and K.M. Wantzen, 2004. The Flood Pulse Concept: New Aspects, Approaches, and Applications – An Update. *In:* Proceedings of the 2nd International Symposium on the Management of Large Rivers for Fisheries Volume 2. RAP Publication, R.L. Welcomme and T. Petr (Editors). Food and Agriculture Organization and Mekong River Commission, Bankok, Thailand, pp. 117-149.

Katibah, E.F., 1984. A Brief History of Riparian Forests in the Central Valley of California. *In:* California Riparian Systems. Ecology, Conservation, and Productive Management, R.E. Warner and K.M. Hendrix (Editors). University of California Press, Berkeley, California, pp. 23-28.

Killgore, K.J. and J.A. Baker, 1996. Patterns of Larval Fish Abundance in a Bottomland Hardwood Wetland. Wetlands 16:288-295.

King, J. and D. Louw, 1998. Instream Flow Assessments for Regulated Rivers in South Africa Using the Building Block Methodology. Aquatic Ecosystem Health and Management 1:109-124.

King, S.L. and B.D. Keeland, 1999. Evaluation of Reforestation in the Lower Mississippi Alluvial Valley. Restoration Ecology 7:348-359.

Knighton, D., 1998. Fluvial Forms and Processes. Arnold, London.

Larsen, E.W., A.K. Fremier, and S.E. Greco, 2006. Cumulative Effective Stream Power and Bank Erosion on the Sacramento River, California, USA. Journal of the American Water Resources Association 42:1077-1097.

Llewellyn, D.W., G.P. Shaffer, N.J. Craig, L. Creasman, D. Pashley, M. Swan, and C. Brown, 1995. A Decision-Support System for Prioritizing Restoration Sites on the Mississippi River Alluvial Plain. Conservation Biology 10:1446-1455.

Magilligan, F.J. and K.H. Nislow, 2005. Changes in Hydrologic Regime by Dams. Geomorphology 71:61-78.

Mahoney, J.M. and S.B. Rood, 1998. Streamflow Requirements for Cottonwood Seedling Recruitment – An Integrative Model. Wetlands 18:634-645.

Mathews, R. and B.D. Richter, 2007. Application of the Indicators of Hydrologic Alteration Software in Environmental Flow Setting. Journal of the American Water Resources Association 43:1400-1413.

Meadows, A.W., D.P. Batzer, M. Alber, and R.R. Sharitz, 2007. Savannah River, Georgia: Science to Support Adaptive Implementation of Environmnetal Flows to a Large Coastal River, Floodplain, and Estuary. Water Resources IMPACT 9:21-24.

Mekong River Commission, 2005. Fisheries Annual Report. Vientiane, Lao P.D.R., Cambodia.

Meyer, J.L., M. Alber, W. Duncan, M. Freeman, C. Hale, R.B. Jackson, C. Jennings, M. Palta, E. Richardson, R. Sharitz, J. Sheldon, and R. Weyers, 2003. Summary Report Supporting the Development of Ecosystem Flow Recommendations for the Savannah River Below Thurmond Dam. The Nature Conservancy.

Mitsch, W.J., J.W. Day, J.W. Gilliam, P.M. Groffman, D.L. Hey, G.W. Randall, and N.M. Wang, 2001. Reducing Nitrogen Loading to the Gulf of Mexico From the Mississippi River Basin: Strategies to Counter a Persistent Ecological Problem. BioScience 51:373-388.

Moyle, P.B., P.K. Crain, and K. Whitener, 2007. Patterns in the Use of a Restored California Floodplain by Native and Alien Fishes. San Francisco Estuary and Watershed Science 5.

Muller-Solger, A.B., A.D. Jassby, and D.C. Muller-Navarra, 2002. Nutritional Quality of Food Resources for Zooplankton (*Daphnia*) in a Tidal Freshwater System (Sacramento-San Joaquin River Delta). Limnology and Oceanography 47:1468-1476.

Murray, B.C., W.A. Jenkins, R.A. Kramer, and S.P. Faulkner, 2009. Valuing Ecosystem Services From Wetlands Restoration in the Mississippi Alluvial Valley. Nicholas Institute for Environmental Policy Solutions, Duke University NI R 09-02, Durham, North Carolina.

Naiman, R.J., H. Decamps, and M.E. McClain, 2005. Riparia: Ecology, Conservation, and Management of Streamside Communities. Elsevier Academic Press, Amsterdam.

Nanson, G.C., 1986. Episodes of Vertical Accretion and Catastrophic Stripping: A Model of Disequilibrium Flood-Plain Development. Geological Society of America Bulletin 97:1467-1475.

Nanson, G.C. and J.C. Croke, 1992. A Genetic Classification of Floodplains. Geomorphology 4:459-486.

Noe, G.B. and C.R. Hupp, 2005. Carbon, Nitrogen, and Phosphorus Accumulation in Floodplains of Atlantic Coastal Plain Rivers, USA. Ecological Applications 15:1178-1190.

Opperman, J.J., G.E. Galloway, J. Fargione, J.F. Mount, B.D. Richter, and S. Secchi, 2009. Sustainable Floodplains Through Large-Scale Reconnection to Rivers. Science 326:1487-1488.

Poff, N.L., J.D. Allan, M.B. Bain, J.R. Karr, K.L. Prestegaard, B.D. Richter, R.E. Sparks, and J.C. Stromberg, 1997. The Natural Flow Regime. BioScience 47:769-784.

Richards, K., J. Brasington, and F. Hughes, 2002. Geomorphic Dynamics of Floodplains: Ecological Implications and a Potential Modelling Strategy. Freshwater Biology 47:559-579.

Richter, B.D. and H.E. Richter, 2000. Prescribing Flood Regimes to Sustain Riparian Ecosystems Along Meandering Rivers. Conservation Biology 14:1467-1478.

Richter, B.D., A.T. Warner, J.L. Meyer, and K. Lutz, 2006. A Collaborative and Adaptive Process for Developing Environmental Flow Recommendations. River Research and Applications 22:297-318.

Rohde, S., M. Hostmann, A. Peter, and K.C. Ewald, 2006. Room for Rivers: An Integrative Search Strategy for Floodplain Restoration. Landscape and Urban Planning 78:50-70.

Rohde, S., M. Shutz, F. Kienast, and P. Englmaier, 2005. River Widening: An Approach to Restoring Riparian Habitats and Plant Species. River Research and Applications 21:1075-1094.

Rood, S.B., C.R. Gourley, E.M. Ammon, L.G. Heki, J.R. Klotz, M.L. Morrison, D. Mosley, G.G. Scoppettone, S. Swanson, and P.L. Wagner, 2003. Flows for Floodplain Forests: A Successful Riparian Restoration. BioScience 53:647-656.

Rood, S.B., G.M. Samuelson, J.H. Braatne, C.R. Gourley, F.M.R. Hughes, and J.M. Mahoney, 2005. Managing River Flows to Restore Floodplain Forests. Frontiers in Ecology and the Environment 3:193-201.

Ross, S.T. and J.A. Baker, 1983. The Response of Fishes to Periodic Spring Floods in a Southeastern Stream. American Midland Naturalist 109:1-14.

Salo, J., R. Kalliola, I. Hakkinen, Y. Makinen, P. Niemela, M. Puhakka, and P.D. Coley, 1986. River Dynamics and the Diversity of Amazon Lowland Forest. Nature 322:254-258.

Schramm, H.L., Jr. and M.A. Eggelton, 2006. Applicability of the Flood Pulse Concept in a Temperate Floodplain River Ecosystem: Thermal and Temporal Components. River Research and Applications 22:543-553.

Sheibley, R.W., D.S. Ahearn, and R.A. Dahlgren, 2006. Nitrate Loss From a Restored Floodplain in the Lower Cosumnes River, California. Hydrobiologia 571:261-272.

Sommer, T., R. Baxter, and B. Herbold, 1997. Resilience of Splittail in the Sacramento-San Joaquin Estuary. Transactions of the American Fisheries Society 126:961-976.

Sommer, T., B. Harrell, M. Nobriga, R. Brown, P. Moyle, W. Kimmerer, and L. Schemel, 2001a. California's Yolo Bypass: Evidence That Flood Control Can Be Compatible With Fisheries, Wetlands, Wildlife, and Agriculture. Fisheries 26:6-16.

Sommer, T.R., W.C. Harrell, A.M. Solger, B. Tom, and W. Kimmerer, 2004. Effects of Flow Variation on Channel and Floodplain Biota and Habitats of the Sacramento River, California, USA. Aquatic Conservation-Marine and Freshwater Ecosystems 14:247-261.

Sommer, T.R., M.L. Nobriga, W.C. Harrell, W. Batham, and W.J. Kimmerer, 2001b. Floodplain Rearing of Juvenile Chinook Salmon: Evidence of Enhanced Growth and Survival. Canadian Journal of Fisheries and Aquatic Sciences 58:325-333.

Stella, J.C., J.J. Battles, B.K. Orr, and J.R. McBride, 2006. Synchrony of Seed Dispersal, Hydrology and Local Climate in a Semi-Arid River Reach in California. Ecosystems 9:1200-1214.

Swenson, R.O., K. Whitener, and M. Eaton, 2003. Restoring Floods on Floodplains: Riparian and Floodplain Restoration at the Cosumnes River Preserve. *In:* California Riparian Systems: Processes and Floodplain Management, Ecology, and Restoration. 2001 Riparian Habitat and Floodplains Conference Proceedings, P.M. Faber (Editor). Riparian Habitat Joint Venture, Sacramento, California, pp. 224-229.

Tobin, G.A., 1995. The Levee Love Affair: A Stormy Relationship. Water Resources Bulletin 31:359-367.

Tockner, K., F. Malard, and J.V. Ward, 2000. An Extension of the Flood Pulse Concept. Hydrological Processes 14:2861-2883.

Tockner, K. and F. Schiemer, 1997. Ecological Aspects of the Restoration Strategy for a River-Floodplain System on the Danube River in Austria. Global Ecology and Biogeography Letters 6:321-329.

Tockner, K. and J.A. Stanford, 2002. Riverine Floodplains: Present State and Future Trends. Environmental Conservation 29:308-330.

Trush, W.J., S.M. McBain, and L.B. Leopold, 2000. Attributes of an Alluvial River and Their Relation to Water Policy and Management. Proceedings of the National Academy of Sciences 97:11858-11863.

Unwin, M.J., 1997. Fry-to-Adult Survival of Natural and Hatchery-Produced Chinook Salmon (Oncorhynchus Tshawytscha) From a Common Origin. Canadian Journal of Fisheries and Aquatic Sciences 54:1246-1254.

Ward, J.V., 1998. Riverine Landscapes: Biodiversity Patterns, Disturbance Regimes, and Aquatic Conservation. Biological Conservation 83:269-278.

Ward, J.V., K. Tockner, D.B. Arscott, and C. Claret, 2002. Riverine Landscape Diversity. Freshwater Biology 47:517-539.

Ward, J.V., K. Tockner, U. Uehlinger, and F. Malard, 2001. Understanding Natural Patterns and Processes in River Corridors as the Basis for Effective River Restoration. Regulated Rivers: Research and Management 17:311-323.

Warner, A.T., 2007. Incorporating Environmental Flows Into Water Management. Water Resources IMPACT 9:6-9.

Welcomme, R.L., 1979. Fisheries Ecology of Floodplain Rivers. Longman Group Ltd., London.

Whiting, P.J., 1998. Floodplain Maintenance Flows. Rivers 6:160-170.

Whiting, P.J., 2002. Streamflow Necessary for Environmental Maintenance. Annual Review of Earth and Planetary Sciences 30:181-206.

Williams, P.B., E. Andrews, J.J. Opperman, S. Bozkurt, and P.B. Moyle, 2009. Quantifying Activated Floodplains on a Lowland Regulated River: Its Application to Floodplain Restoration in the Sacramento Valley. San Francisco Estuary and Watershed Science 7. http://repositories.cdlib.org/jmie/sfews/vol7/iss1/art4, *accessed* February 20, 2010.

Wohl, E.E., 2000. Geomorphic Effects of Floods. *In:* Inland Flood Hazards: Human, Riparian, and Aquatic Communities, E.E. Wohl (Editor). Cambridge University Press, Cambridge, United Kingdom, pp. 167-193.

Attachment C

Comments on the Final Environmental Impact Statement for the Yazoo Backwater Area Water Management Project, November 2024

Submitted by

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

December 30, 2024

RIVER RESEARCH AND APPLICATIONS

River Res. Applic. **22**: 543–553 (2006)

Published online 14 March 2006 in Wiley InterScience
(www.interscience.wiley.com). DOI: 10.1002/rra.921

APPLICABILITY OF THE FLOOD-PULSE CONCEPT IN A TEMPERATE FLOODPLAIN RIVER ECOSYSTEM: THERMAL AND TEMPORAL COMPONENTS

HAROLD L. SCHRAMM, JR.,[a]* and MICHAEL A. EGGLETON[b]

[a] *U.S. Geological Survey, Mississippi Cooperative Fish and Wildlife Research Unit, Mail Stop 9691, Mississippi State, MS 39762 USA*
[b] *Aquaculture/Fisheries Center, University of Arkansas at Pine Bluff, Box 4912, Pine Bluff, AR 71601 USA*

ABSTRACT

Annual growth increments were calculated for blue catfish (*Ictalurus furcatus*) and flathead catfish (*Pylodictis olivaris*) from the lower Mississippi River (LMR) to assess hypothesized relationships between fish growth and floodplain inundation as predicted by the Flood-Pulse Concept. Variation in catfish growth increment was high for all age classes of both species, and growth increments were not consistently related to various measures of floodplain inundation. However, relationships became stronger, and usually direct, when water temperature was integrated with area and duration of floodplain inundation. Relationships were significant for four of six age classes for blue catfish, a species known to utilize floodplain habitats. Though similar in direction, relationships were weaker for flathead catfish, which is considered a more riverine species. Our results indicate the Flood-Pulse Concept applies more strongly to temperate floodplain-river ecosystems when thermal aspects of flood pulses are considered. We recommend that future management of the LMR should consider ways to 'recouple' the annual flood and thermal cycles. An adaptive management approach will allow further determination of important processes affecting fisheries production in the LMR. Copyright © 2006 John Wiley & Sons, Ltd.

KEY WORDS: flood-pulse concept; regulated rivers; floodplain; Mississippi River; catfishes

INTRODUCTION

Contemporary models of river-floodplain ecosystems predict that fish production is positively related to some measure of inundated floodplain habitat (Junk *et al.*, 1989; Welcomme, 1985). Although conceptualized as a model for large floodplain rivers in general, support for this 'Flood-Pulse' Concept (Junk *et al.*, 1989) largely emanates from studies of little-altered, tropical river systems. In these systems, floodplain inundation tends to be spatially expansive, protracted and temporally consistent (Goulding, 1980). The hydrographs in these rivers are mostly unchanged from historical conditions and water temperatures are relatively stable and sufficient for high rates of food intake and growth by most fishes throughout the year (Humphries *et al.*, 1999). Conversely, most rivers in temperate zones are highly altered systems with respect to channel alignment, annual flow regimes, and floodplain connectivity (Sparks, 1995a,b; Poff *et al.*, 1997). Because of these characteristics, temperate rivers also may exhibit a general asynchrony between annual flood pulses and water temperatures suitable for feeding and growth of many temperate fishes (Schramm *et al.*, 2000; Eggleton and Schramm, 2004).

There is considerable interest in restoring large floodplain-river ecosystems (Gore and Shields, 1995), and the Flood-Pulse Concept provides ample guidance for restoration efforts. However, many candidate rivers for restoration are in temperate regions. Evaluations of the Flood-Pulse Concept in temperate rivers have not provided compelling evidence for its applicability in these systems. In the upper Mississippi River, growth of floodplain-dependent fishes was greater during a year of extensive summer flooding compared to other years while growth of a

*Correspondence to: Harold L. Schramm, Jr., Mississippi Cooperative Fish and Wildlife Research Unit, Mail Stop 9691, Mississippi State, MS 39762, USA. E-mail: hschramm@cfr.msstate.edu

Received 15 May 2004
Revised 1 August 2005
Accepted 15 September 2005

riverine species did not differ during that year (Gutreuter *et al.*, 1999). However, studies in the lower Mississippi River (LMR) have failed to detect expected positive relationships between growth and abundance of young fishes and measures of floodplain inundation (Rutherford *et al.*, 1995). Additional studies in the LMR also suggested that catfish (Ictaluridae) growth was not significantly related to area or duration of floodplain inundation (Mayo, 1999; Schramm *et al.*, 2000). However, positive relationships emerged between catfish growth and extent of inundation when water temperature exceeded 15°C, a threshold temperature for active feeding and growth by catfishes (Schramm *et al.*, 2000). Although these results are compatible with the 'thermal coupling' hypothesis offered by Junk *et al.* (1989), validation over a longer time frame is needed before thermal coupling can be considered a viable restoration objective for the LMR.

The objectives of this paper are to (1) evaluate relationships between growth of ictalurid catfishes and temporal, spatial and thermal measures of floodplain inundation associated with annual flood pulses in the LMR, and (2) propose an adaptive management strategy that should benefit LMR fish production and allow further evaluation of the habitat conditions affecting it. Results will enable a better understanding of river-floodplain linkages in highly altered large rivers that are commonplace in the temperate region.

METHODS

Study site

The LMR is the 1,600 km segment of the Mississippi River from the confluence of the Ohio River to the Gulf of Mexico. The LMR has received extensive bank armouring and placement of large-rock wing dikes to control channel alignment and maintain sufficient depth for commercial navigation (Fremling *et al.*, 1989; Schramm, 2004). Although regulated, the LMR remains free-flowing throughout and flooding regime varies annually. During the period 1940–2001, which reflects the current state of regulation, significant floodplain inundation occurs annually from mid-March through mid-May, though flooding may begin as early as January and continue into summer (Schramm, 2004). Annual stage fluctuations average about 8 m per year, but may exceed 15 m (Baker *et al.*, 1991). Extensive levee construction during the last 150 years has separated approximately 93% of the historical floodplain from the main river channel (Sparks *et al.*, 1998). This reduction in river-floodplain connectance has had unknown, but presumed negative, effects on riverine fishes and fisheries. However, at present, more than 6,000 km^2 (average 3.8 km^2 per river km) of active, annually inundated floodplain remains (Schramm *et al.*, 1999).

Fish collection

We selected blue catfish (*Ictalurus furcatus*) and flathead catfish (*Pylodictis olivaris*) to assess relationships between fish growth and floodplain inundation measures. While longitudinal movement of these fishes in rivers has been studied (Graham, 1999; Jackson, 1999), little information is available about lateral, river-floodplain movements. In the LMR, blue catfish extensively use the floodplain, but flathead catfish largely remain in the main river channel and adjacent habitats (e.g., side or secondary river channels) (Eggleton and Schramm, 2004). The widely different life-history strategies of these two species may help unravel fish-floodplain relationships in the LMR.

We collected 899 catfishes 250–700 mm total length by 15-Hz pulsed D.C. boat-mounted electrofishing from main river channel habitats. Samples were taken between river km 716–942 during July–October 1996–1997 and September 2000–2003. All fishes were measured for total length, and a pectoral spine was removed before the fish were released. Following the method of Lee (1983), individuals were aged by microscopic examination of articulating process cross sections, with annular measurements obtained from basal recess cross sections perpendicular to the axis of the spine.

Data analyses

Lengths at age were backcalculated by direct proportion (Schramm *et al.*, 1992). The possibility of a Lee effect (i.e., backcalculated lengths that do not accurately represent the lengths at earlier ages) was tested by comparing the slope of lengths at age 1 regressed against age for four cohorts for each species. A zero slope would indicate no

Lee effect. For blue catfish, two cohorts had slopes that did not differ from zero, one cohort had a positive slope, and the other cohort had a negative slope. Identical results were obtained with analyses of four cohorts of flathead catfish. Thus, we concluded no consistent Lee effect and backcalculated lengths from all annuli were considered accurate representations of catfish lengths at the time of annuli formation.

Annual growth increments were estimated from the backcalculated lengths at the time of annuli formation. Age-0 growth was the backcalculated length at the first annulus, age-1 growth was the backcalculated length at age 2 (second annulus) minus the backcalculated length at age 1, and so forth. Blue and flathead catfishes in LMR form annuli on their pectoral spines during May–July (Mayo, 1999). Thus, the growth year for both catfishes was assumed to be 1 July–30 June. Since the annual flood pulse generally began in March of each year, potential energetic benefits could be realized by the end of the July–June growth year or at the beginning of the succeeding growth year. As analyses proceeded, results indicated that environmental conditions in the spring (March–June) often showed better association with environmental conditions during the succeeding summer-fall (July–November) period than the preceding summer, which constituted a different growth year. Therefore, relationships between growth increment and environmental conditions were evaluated both for growth year (GY, July–June; e.g., 1992 growth year was July 1991–June 1992) and calendar year (CY, January–December). Measures of floodplain inundation for both growth and calendar years were the sum of spring and summer-fall measures (i.e., inundation during December–February was excluded).

Floodplain inundation metrics tested for association with catfish growth increment included variables that depicted river stage, river water temperature, total areas of inundated floodplain habitat, duration of floodplain inundation, and lengths of the growing season for catfishes (i.e., days when water temperature was $\geq 15°C$). Several of these variables were combined to depict multidimensional variables (Table I). For instance, total area of inundated floodplain and duration of floodplain inundation were combined into a single variable termed 'area-days of flooding', which reflected a measure more ecologically meaningful to fishes. Daily river stages were obtained from the U.S. Army Corps of Engineers, Vicksburg District. River water temperatures were obtained from the U.S. Geological Survey and U.S. Army Corps of Engineers. Area of inundated floodplain at different river stages was calculated using Geographic Information Systems technology on a LMR spatial data set provided by the U.S. Army Corps of Engineers (Schramm *et al.*, 1999). Floodplain water temperatures generally ranged 1–4°C higher than temperatures in the main river channel (Eggleton, 2001). Thus, a temperature of 15°C in the river approximated a temperatures range of 16–20°C in floodplain habitats, which are threshold temperatures at which ictalurid catfishes resumed active feeding and growth (Stickney, 1988; Tucker and Robinson, 1990).

Differences in annual growth increments were tested among years for six age classes of blue catfish and five age classes of flathead catfish by one-way completely randomized analysis of variance (ANOVA). Results were judged statistically significant at $\alpha = 0.05$. Relationships between environmental variables (Table I) and growth increment were assessed by Spearman rank correlation analyses. Only cohorts with nine or more fish in an age class were included in correlation analyses. Correlations were considered significant at $\alpha = 0.10$. The higher α was chosen because of smaller sample sizes (years served as replicates in the correlation analyses) and to ensure that possible growth-environmental relationships were not overlooked due to statistical power issues.

RESULTS

For blue catfish, annual growth increments differed among years for three of seven age classes (Table II). For the age classes of blue catfish that exhibited significant annual differences in growth, GY 1996 (CY 1995) appeared to be a year of consistently greater growth, and mean annual growth increments exceeded long-term averages by as much as 19%. Specifically, growth increments of age-0 fish were significantly greater in GY 1996 than during 5 of 11 other years. During the same growth year, growth increments of age-2 fish significantly exceeded growth during 6 of 10 other years. A consistent but weaker pattern was observed with age-4 fish; although the largest growth increment was measured in GY 1996, this growth increment was significantly greater than only one of the other nine growth years (Table II). Growth increments of age-1, age-3, and age-5 fish in GY 1996 exceeded long-term averages, but the greater growth increments were not significantly different from other growth years. Annual

Table I. Environmental variables tested for association with annual growth increment of blue catfish and flathead catfish in the lower Mississippi River. Growth year is the 12-month time period from July–June; calendar year is the 12-month time period from January–December

Variable (units)	Definition	Minimum	Maximum
Mean stage (m)	Mean river elevation above low-water reference plane	9.7	29.8
Mean temperature (°C)	Mean main river channel water temperature	15.9	18.3
Mean flooded area of floodplain waterbodies (ha)			
March–June, growth year	Mean flooded area during March–June of growth year	134076	900320
March–June, calendar year	Mean flooded area during March–June of calendar year	134076	900320
July–November	Mean flooded area during July–November (same for growth and calendar years)	55680	494222
Annual, growth year	Mean flooded area during July–June	216200	1026822
Annual, calendar year	Mean flooded area during March–November	215840	1375537
Flood days (number of days above flood stage = 7.6 m stage)			
March–June, growth year	Number of March–June days above flood stage of growth year	15	122
March–June, calendar year	Number of March–June days above flood stage of calendar year	15	122
July–November	Number of July–November days above flood stage (same for growth and calendar years)	0	102
Annual, growth year	Number of July–June days above flood stage	194	27
Annual, calendar year	Number of March–November days above flood stage	28	224
Area-days of flooding (cumulative area of flooding through days of flooding)			
March–June, growth year	Cumulative area of days of flooding during March–June of growth year	5	107
March–June, calendar year	Cumulative area of days of flooding during March–June of calendar year	5	107
July–November	Cumulative area of days of flooding during July–November (same for growth and calendar years)	0	68
Annual, growth year	Cumulative area of days of flooding during July–June	9	172
Annual, calendar year	Cumulative area of days of flooding during March–November	9	175
Length of growing season	Number of days with water temperature exceeding 15°C	180	231
Days of flooding when water temperature >15°C (number of days)			
March–June, growth year	March–June days above flood stage when water temperature exceeds 15°C for growth year	6	77
March–June, calendar year	March–June days above flood stage when water temperature exceeds 15°C for calendar year	6	83
July–November	July–November days above flood stage when water temperature exceeds 15°C	0	92
Annual, growth year	July–June days above flood stage when water temperature exceeds 15°C	6	134
Annual, calendar year	March–November days above flood stage when water temperature exceeds 15°C	12	144
Area-days of flooding when water temperature >15°C (area-days above 15°C)			
March–June, growth year	March–June area-days of flooding (defined above) when water temperature exceeded 15°C during growth year	2	72
March–June, calendar year	March–June area-days of flooding when water temperature exceeded 15°C during calendar year	2	72
July–November	July–November area-days of flooding when water temperature exceeded 15°C (same for growth and calendar years)	0	62
Annual, growth year	July–June area-days of flooding when water temperature exceeded 15°C	2	110
Annual, calendar year	March–November area-days of flooding when water temperature exceeded 15°C	4	103

Table II. Mean annual growth increments of blue catfish in the lower Mississippi River. Values in parentheses are number of fish, standard error. Growth year is the annual period from July to June of the succeeding year; e.g., July 1990–June 1991 is growth year 1991. Calendar year is the annual period from January–December

Calendar year	Growth year	Growth increment						
		Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6
1990	1991	161[a] (19, 9.8)						
1991	1992	161[a] (54, 4.5)	70[a] (19, 5.8)					
1992	1993	150[a,b] (55, 4.1)	71[a] (54, 3.5)	61[b] (21, 3.3)				
1993	1994	144[b] (143, 2.6)	80[a] (55, 3.7)	71[b] (57, 3.1)	66[a] (21, 4.3)			
1994	1995	153[a,b] (51, 4.7)	74[a] (143, 1.8)	71[b] (59, 3.6)	75[a] (57, 2.9)	63[a,b] (21, 4.8)		
1995	1996	176[a] (24, 9.2)	82[a] (51, 3.4)	85[a] (147, 1.9)	75[a] (59, 2.9)	76[a] (57, 2.6)	127[a] (20, 7.5)	
1996	1997	142[b] (37, 6.3)	83[a] (24, 3.3)	72[a,b] (37, 3.9)	65[a] (36, 4.2)	54[b] (17, 4.4)	117[a] (9, 5.6)	58[a] (8, 4.1)
1997	1998	156[a,b] (60, 5.8)	82[a] (37, 3.7)	66[b] (24, 3.7)	64[a] (28, 4.4)	60[a,b] (24, 4.9)	108[a] (15, 6.9)	62[a] (5, 6.5)
1998	1999	151[a,b] (48, 5.4)	76[a] (60, 2.9)	76[a,b] (39, 4.2)	75[a] (24, 5.5)	66[a,b] (28, 5.2)	125[a] (24, 7.3)	59[a] (15, 6.2)
1999	2000	128[c] (63, 4.5)	74[a] (48, 3.4)	66[b] (61, 3.1)	67[a] (38, 4.2)	67[a,b] (24, 5.8)	123[a] (28, 6.4)	55[a] (24, 3.6)
2000	2001	141[b] (38,10.5)	77[a] (63, 3.4)	74[a,b] (39, 4.4)	68[a] (34, 4.5)	57[a,b] (13, 3.8)	128[a] (18, 11.9)	54 (18, 4.5)
2001	2002	109[c] (10, 8.3)	81[a] (38, 8.0)	69[b] (44, 3.8)	65[a] (21, 4.8)	63[a,b] (20, 5.2)	111[a] (5, 7.7)	52[a] (11, 4.6)
2002	2003		94[a] (10, 4.5)	77[a,b] (27, 6.3)	69[a] (37, 5.0)	68[a,b] (14, 6.6)	137[a] (13, 12)	40[a] (4, 1.7)
1990–2002	Mean	148 (602, 5.0)	79 (602, 1.9)	72 (555, 1.9)	69 (355, 1.4)	64 (218, 2.2)	122 (132, 3.4)	54 (85, 2.7)

[a,b,c]Values in a column with a different letter are significantly different ($p < 0.05$) by least squares means.

growth increment of age-5 blue catfish across all years (mean = 122 mm) was consistently greater than annual growth increment of all other age classes (means 54–79 mm) except age-0.

For flathead catfish, annual growth increments differed among years for three of six age classes (Table III). However, greater growth across the different age classes was not consistently associated with one or more growth year(s). Growth increments of age-0 fish were significantly greater during GY 1998 than during 2 of 10 other growth years. Growth increments of age-1 fish were significantly greater during GY 1996 than during 2 of 10 other growth years. Growth increments of age-4 fish were significantly greater in GY 2003 than

Table III. Mean annual growth increments of flathead catfish in the lower Mississippi River. Values in parentheses are number of fish, standard error. Growth year is the annual period from July to June of the succeeding year; e.g., July 1990–June 1991 is growth year 1991. Calendar year is the annual period from January–December

Calendar year	Growth year	Growth increment					
		Age 0	Age 1	Age 2	Age 3	Age 4	Age 5
1991	1992	155[a,b] (12, 12.0)					
1992	1993	160[a,b] (10, 12.3)	60[b] (12, 7.5)				
1993	1994	162[a,b] (27, 11.5)	77[a,b] (10, 11.1)	64[a] (13, 9.1)			
1994	1995	156[a,b] (26, 10.5)	72[b] (27, 5.9)	94[a] (15, 8.8)	70[a] (13, 10.6)		
1995	1996	173[a,b] (13, 10.8)	101[a] (26, 7.8)	91[a] (31, 5.6)	85[a] (16, 9.0)	85[b] (13, 12.8)	
1996	1997	171[a,b] (17, 7.4)	85[a,b] (13, 11.2)	94[a] (21, 8.5)	72[a] (16, 9.3)	54[b] (3, 17.5)	106[a] (3, 25.4)
1997	1998	183[a] (33, 11.3)	77[a,b] (17, 9.5)	71[a] (12, 11.5)	94[a] (13, 13.6)	63[b] (8, 10.0)	141[a] (2, 24.1)
1998	1999	156[a,b] (38, 7.3)	88[a,b] (33, 7.3)	84[a] (23, 7.5)	91[a] (12, 18.1)	76[b] (13, 10.6)	145[a] (8, 19.6)
1999	2000	166[a,b] (55, 6.3)	76[a,b] (38, 5.0)	82[a] (42, 7.4)	82[a] (23, 9.0)	82[b] (12, 13.4)	130[a] (13, 15.5)
2000	2001	151[b] (51, 6.0)	83[a,b] (55, 4.3)	80[a] (34, 5.6)	86[a] (27, 6.6)	77[b] (9, 15.7)	191[a] (4, 40.6)
2001	2002	134[b] (15, 7.1)	87[a,b] (51, 4.6)	83[a] (38, 7.6)	79[a] (19, 9.4)	87[b] (10, 14.2)	115[a] (3, 26.5)
2002	2003		98[a,b] (15, 8.8)	97[a] (26, 9.9)	106[a] (26, 10.7)	144[a] (17, 15.7)	180[a] (8, 20.9)
1990–2002	Mean	161 (297,13.9)	82 (297, 7.6)	84 (255, 8.2)	85 (165, 9.1)	84 (85, 12.5)	144 (41, 20.8)

[a,b]Values in a column with a different letter are significantly different ($p < 0.05$) by least squares means.

in all 7 years available for comparison. Though not significant, annual growth increments of age-3 and age-5 flathead catfish were 25% greater in GY 2003 than in all other years. As observed for blue catfish, annual growth increment of age-5 flathead catfish (mean = 144 mm) was greater than annual growth increments of ages 1–4 (means 82–85 mm) (Table III).

Fish growth-environment correlations for blue catfish were generally low and nonsignificant for measures of mean stage, mean water temperature, area of flooded floodplain waterbodies, and days of floodplain inundation (Table IV). Annual growth increment was positively related to days of flooding during July–November when river water temperature exceeded 15°C for four of six age classes. Annual growth increment was positively related to area-days of floodplain inundation when water temperature exceeded 15°C during March–June (CY) and during the entire CY for four of six age classes.

Table IV. Spearman rank correlation coefficients between environmental variables and annual growth increments of length of blue catfish. Correlation coefficients in bold are significantly different ($p < 0.10$) from zero. Growth year is the annual period, or portion thereof, from July to June of the succeeding year. Calendar year is the annual period, or portion thereof, from January–December

Environmental variable	Growth increment					
	Age 0 ($n = 12$)	Age 1 ($n = 13$)	Age 2 ($n = 12$)	Age 3 ($n = 11$)	Age 4 ($n = 10$)	Age 5 ($n = 7$)
Mean stage	0.08	0.10	0.10	−0.30	0.01	0.39
Mean temperature	−0.30	0.04	−0.11	0.23	−0.15	−0.32
Mean flooded area of floodplain waterbodies						
March–June, growth year	−0.04	0.20	−0.12	**−0.64**	−0.21	0.14
March–June, calendar year	**0.54**	−0.05	0.08	0.20	0.21	0.14
July–November	0.11	0.27	0.25	0.02	0.30	0.04
Annual, growth year	−0.01	0.21	−0.05	**−0.56**	−0.07	0.14
Annual, calendar year	0.47	−0.05	0.18	0.32	0.35	0.36
Flood days						
March–June, growth year	0.11	0.09	−0.12	**−0.54**	−0.30	0.25
March–June, calendar year	0.35	−0.21	−0.02	0.16	0.33	0.00
July–November	−0.11	0.36	0.44	0.24	0.29	0.13
Annual, growth year	0.07	0.16	−0.02	−0.47	−0.09	0.07
Annual, calendar year	0.25	0.00	0.10	0.17	0.38	−0.04
Area-days of flooding						
March–June, growth year	**0.54**	−0.05	0.08	0.20	0.21	0.14
March–June, calendar year	−0.01	−0.13	−0.20	−0.51	−0.20	0.36
July–November	−0.04	0.20	−0.12	**−0.64**	−0.21	0.14
Annual, growth year	0.29	0.20	0.20	−0.02	−0.01	0.07
Annual, calendar year	−0.09	0.11	−0.11	**−0.61**	−0.21	0.11
Length of growing season (water temperature >15°C)	0.29	0.20	0.20	−0.02	−0.01	0.07
Days of flooding when water temperature >15°C	0.41	0.12	0.56	0.62	0.58	0.68
March–June, growth year	−0.19	−0.12	0.14	**0.56**	−0.06	−0.21
March–June, calendar year	0.07	−0.20	−0.17	−0.45	−0.19	0.36
July–November	0.41	0.11	**0.56**	**0.62**	**0.58**	**0.68**
Annual, growth year	0.32	−0.09	0.24	**0.58**	0.44	0.20
Annual, calendar year	0.40	0.22	**0.53**	0.46	**0.71**	0.54
Area-days of flooding when water temperature >15°C						
March–June, growth year	0.19	0.14	0.08	−0.08	0.13	0.31
March–June, calendar year	**0.56**	0.21	**0.65**	**0.60**	0.38	**0.82**
July–November	−0.07	0.37	0.31	0.15	0.34	0.07
Annual, growth year	0.15	0.26	0.20	−0.02	0.38	0.25
Annual, calendar year	0.45	0.26	**0.64**	**0.57**	**0.59**	**0.79**

Flathead catfish annual growth increment was only weakly related to mean stage, mean water temperature, area of flooded floodplain waterbodies, and days and area-days of floodplain inundation (Table V). Annual growth increment was positively related to days of flooding when river water temperature exceeded 15°C during July–November, but only for age-1 fish. Annual growth increment was positively related to area-days of floodplain inundation when temperature exceeded 15°C during March–June (CY) for two of five age classes, but negatively related to area-days of floodplain inundation when temperature exceeded 15°C during July–November for age-2 fish.

Temporal and thermal aspects of floodplain inundation were highly variable during 1990–2002. A notable flood occurred in the Mississippi River basin during CY 1993; floodwaters remained on the floodplain in much of the LMR from February through September. During this period, water temperatures in the LMR exceeded 15°C for 144 consecutive days (Figure 1). Relatively long periods of floodplain inundation also occurred in CY 1990, 1991, 1994–1999, and 2002. However, periods of floodplain inundation when river temperatures were ≥ 15°C exceeded 90 days only during CY 1990, 1995, and 1998.

Table V. Spearman rank correlation coefficients between environmental variables and annual growth increments of length of flathead catfish. Correlation coefficients in bold are significantly different ($p < 0.10$) from zero. Growth year is the annual period, or portion thereof, from July to June of the succeeding year. Calendar year is the annual period, or portion thereof, from January–December

Environmental variable	Growth increment				
	Age 0 ($n = 11$)	Age 1 ($n = 11$)	Age 2 ($n = 10$)	Age 3 ($n = 9$)	Age 4 ($n = 5$)
Mean stage	0.39	−0.09	−0.16	−0.07	−0.20
Mean temperature	−0.24	0.06	0.09	−0.05	−0.30
Mean flooded area of floodplain waterbodies					
March–June, growth year	0.33	−0.25	−0.07	−0.30	0.60
March–June, calendar year	0.42	0.04	−0.09	0.25	−0.30
July–November	**0.58**	0.17	−0.47	0.20	−0.60
Annual, growth year	0.37	−0.18	−0.22	−0.27	0.60
Annual, calendar year	0.33	0.13	−0.09	0.33	−0.30
Flood days (stage > 7.6 m LWRP)					
March–June, growth year	0.32	−0.08	−0.09	0.03	−0.10
March–June, calendar year	0.33	0.02	−0.29	0.41	−0.40
July–November	0.41	0.28	−0.40	0.27	−0.70
Annual, growth year	0.42	−0.15	−0.47	0.10	−0.20
Annual, calendar year	**0.57**	0.13	−0.39	0.33	−0.40
Area-days of flooding in March–June					
March–June, growth year	0.42	0.04	−0.09	0.25	−0.30
March–June, calendar year	0.06	−0.15	−0.08	−0.30	0.30
July–November	0.33	−0.25	−0.07	−0.30	0.60
Annual, growth year	0.51	0.03	−0.13	−0.07	−0.10
Annual, calendar year	0.24	−0.24	−0.08	−0.42	0.60
Length of growing season (water temperature > 15°C)	0.51	0.03	−0.13	−0.07	−0.10
Days of flooding when water temperature > 15°C					
March–June, growth year	−0.27	−0.02	0.17	−0.15	−0.60
March–June, calendar year	0.09	−0.14	−0.07	−0.23	−0.10
July–November	0.42	**0.64**	0.44	0.47	−0.30
Annual, growth year	0.18	0.35	0.47	0.27	−0.20
Annual, calendar year	0.50	0.46	0.05	0.30	0.00
Area-days of flooding when water temperature > 15°C					
March–June, growth year	0.06	0.07	0.07	−0.32	0.60
March–June, calendar year	0.37	**0.59**	**0.74**	0.13	0.00
July–November	0.47	0.28	**−0.61**	0.37	−0.67
Annual, growth year	0.25	0.15	−0.24	−0.13	0.50
Annual, calendar year	0.33	0.47	0.16	0.23	−0.30

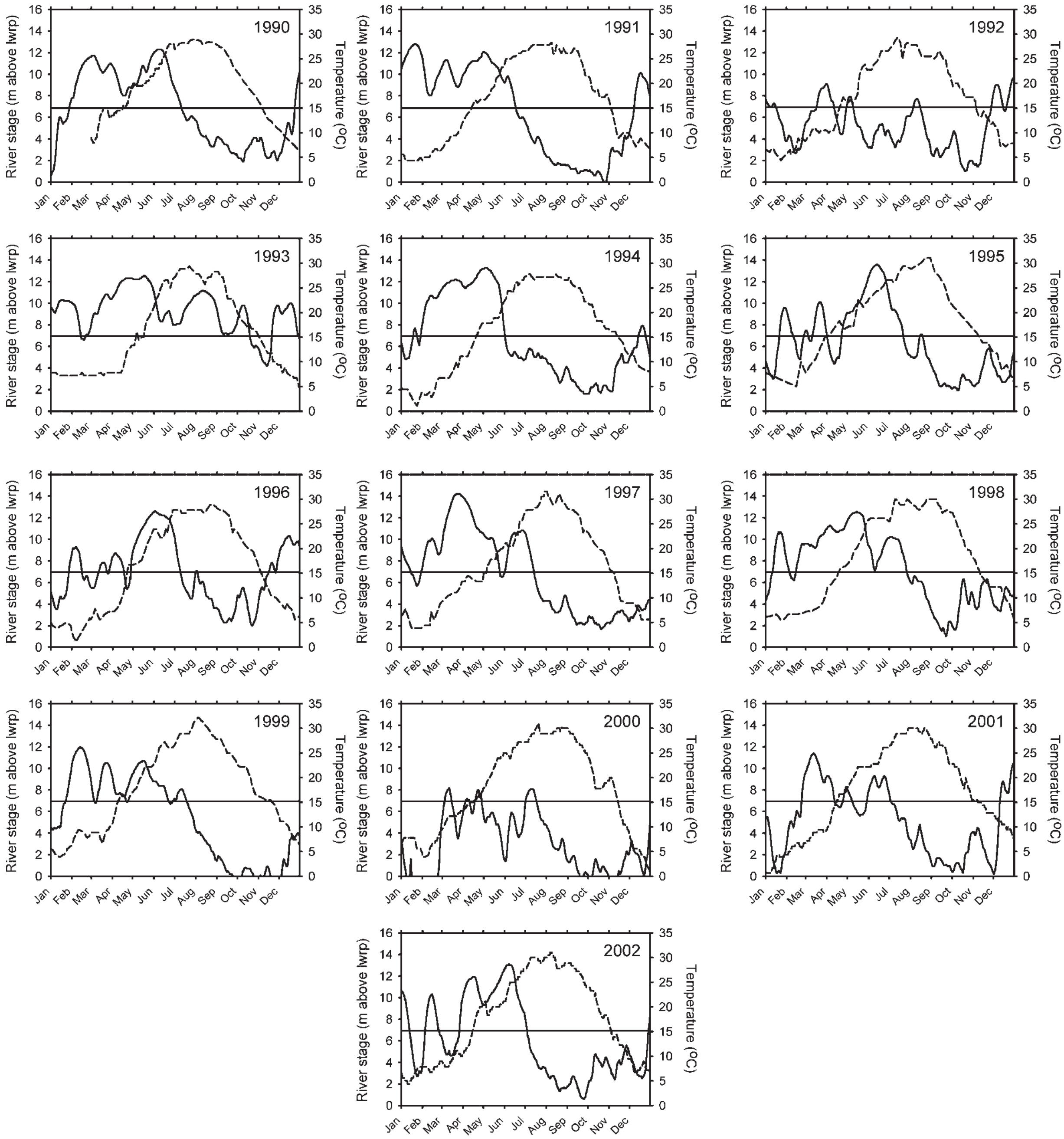


Figure 1. Stage (solid line) and temperature (dashed line) of the Mississippi River measured at Vicksburg, Mississippi for calendar years 1990–2002. Horizontal line is the approximate stage at which water commences to move laterally onto the floodplain; lwrp is low water reference plane, the river stage at which discharge is exceeded during 95% of the time of measurement

DISCUSSION

Annual growth increments varied among years for each age class of both blue catfish and flathead catfish; but, overall, the variation for both species was smaller than we expected in a highly variable environment such as the LMR. The magnitude of the potential variation in growth rate was illustrated by the substantially greater growth increment for age 5 than for other age classes for both species. Nevertheless, some variation in growth occurred among years for both species.

Blue catfish and flathead catfish are native to warmwater rivers of the central United States including the Mississippi River (Graham, 1999; Jackson, 1999). Our expectation was that their growth would be influenced by thermal and hydrological conditions associated with spring flood pulses. We did not detect consistent positive relationships between mean temperature, length of growing season, mean river stage, or areal and temporal measures of inundated floodplain habitat as predicated by basic fish growth-temperature responses (Welcomme, 1979; Weatherly and Gill, 1987) or the Flood-Pulse Concept (Junk *et al.*, 1989). However, for blue catfish, we did find positive relationships between annual growth increment and days or area-days of floodplain inundation when river water temperature exceeded 15°C, a temperature approximating the thermal threshold for active feeding and growth by ictalurid catfishes. Further, growth increment was consistently greater across year classes during GY 1996 (CY 1995), a year of protracted warm-water floodplain inundation. This corroborates previous findings by Schramm *et al.* (2000) and supports the 'thermal coupling' component of the Flood-Pulse Concept proposed by Junk *et al.* (1989).

We did not find consistent positive relationships between temporal or spatial measures of floodplain inundation when water temperature exceeded 15°C for flathead catfish. Unlike blue catfish, which forage extensively on inundated floodplain habitats (Eggleton and Schramm, 2004), we rarely collected flathead catfish in LMR floodplain habitats. Hence, lack of significant positive relationships with floodplain inundation measures is not unexpected. The absence of a year or years of consistently enhanced growth across age classes of flathead catfish, in contrast to the consistently high growth increments across age classes of blue catfish in GY 1996, also suggests differences in use and growth benefit of the floodplain between the two catfish species. Similar results were obtained in the upper Mississippi River where growth of floodplain-dependent fishes was increased during CY 1993, a year of protracted, summer floodplain inundation (Gutreuter *et al.*, 1999). Consistent with our results, no growth response was detected in that study for a more riverine species.

Unlike the results obtained by Gutreuter *et al.* (1999), we did not find increased growth increment associated with the protracted flooding in the LMR during 1993. Growth is one component of fish production, but recruitment also is important. Our sampling was not designed to measure or estimate catfish recruitment rates. However, strong reproduction and recruitment for the 1993 year class of blue catfish can be inferred from the greater numbers of fish of that cohort available for growth increment analyses (Table II).

Implications for conservation and management of the lower Mississippi River

Our results corroborate and expand on an earlier study by Schramm *et al.* (2000), which indicated that growth of catfishes in the LMR was linked to floodplain inundation, but only when water temperatures were sufficient for active catfish feeding and growth. This finding also agrees with greater growth of floodplain fishes observed in the upper Mississippi River during an unusual year (the 'flood of 1993') when floodplain inundation persisted throughout summer, thus providing warm water coincident with floodplain inundation. However, it is apparent from our results is that warm-water floodplain inundation accounts for only a moderate portion of the variation in growth of floodplain fishes. Future studies in the LMR need to address other possibilities, such as annual variation in primary catfish prey items (e.g., fishes, decapod crustaceans, and molluscs; Eggleton and Schramm, 2004), habitat quality and quantity, local nutrient sources, or possible interactions within and between catfish populations (e.g., Edds *et al.*, 2002).

Rutherford *et al.* (1995) suggested that the lack of expected positive relationships between fish growth and floodplain inundation in the lower Mississippi River may have been attributed to the high degree of alteration of this system, particularly the loss of connectivity with more than 90% of the historical floodplain. Evidence from various floodplain-river ecosystems supports the importance of floodplain connectivity (e.g., Welcomme, 1979; Heiler *et al.*, 1995; Ward and Stanford, 1995; Tockner *et al*., 1999). Although the LMR has lost much of its historic floodplain, an expansive active floodplain still remains.

Considering that a substantial floodplain is still connected to the LMR, attributing lack of energetic and reproductive benefits to historic loss of floodplain may be premature without considering thermal factors. Grubaugh and Anderson (1988) reported that the present-day upper Mississippi River flooded earlier and for shorter duration than it did historically during a period of record exceeding 100 years. They concluded that excessive channelization and flood control practices throughout the basin contributed most to the altered flood pulse. Retention of floodwaters in floodplains, as occurs in an unaltered river-floodplain system, would be expected to moderate water temperatures during annual flood pulses, thereby creating a more suitable thermal environment for warmwater fishes. The consequences of an earlier and abbreviated flood pulse may be exacerbated in temperate rivers, which show distinct warm-cold cycles.

The LMR may fall into this category. During 1933–1942, 16 bendway cutoffs shortened the river by 245 km (Baker *et al.*, 1991). The morphology of the LMR is a product of many influences, precluding cause-effect relationships for an individual factor. However, man-made cutoffs and the associated channel aggradation and degradation, which promote lesser connectance with floodplains, have had the most dramatic effect of any occurrence on channel morphology (Biedenharn and Watson, 1997). Based on river stage data collected at Vicksburg, Mississippi (river km 702, 14 km downstream of our lowermost sampling site), the average period of floodplain inundation was 4–5 months (early February through early July) prior to cut-off construction compared to 2 months (mid-March to mid-May) following cutoff construction (Schramm, 2004). As evident from Figure 1, thermal conditions of these altered flood pulses vary among years, though river water temperatures typically reach 15°C by mid-April. Thus, under the current hydrographic conditions in the LMR, the duration of floodplain inundation when water temperature exceeds 15°C is only about 1 month per year on average. Such a brief period of time may be insufficient for floodplain-foraging fishes like the blue catfish (and other fishes; see Schramm, 2004) to achieve a detectable energetic benefit. The abbreviated period of warm, flooded conditions also would be expected to adversely affect recruitment of numerous warmwater fishes (Schramm *et al.*, 2000).

The alteration of the thermal cycle is compounded by the main line levees in the LMR that constrain floodwaters, resulting in deeper, more swiftly-flowing waters on the floodplain. This hydrological characteristic, likely common in many temperate river systems, may further impede water warming when compared to shallower water spread over an expansive floodplain. Further, the narrower, leveed floodway is more prone to rapid rises and falls, reducing the 'flood-pulse advantage' proposed by Bayley (1991). Thus, the cutoffs and levees in the LMR in concert may function to reduce fishery productivity benefits from a more prolonged and thermally desirable flood pulse.

Returning the LMR to historical hydrological conditions is a paramount component of floodplain river restoration (Bayley, 1991; Sparks *et al.*, 1998). In the LMR, this strategy would help 'recouple' the natural thermal and hydrological conditions. In the unimpounded LMR, restoring the hydrograph will require restoring the sinuosity (and thus, the length and slope) of the main channel and the width of the floodplain. Because of the importance of the LMR for navigation and flood control, restoring the sinuosity and removing the levees is extremely unlikely.

Gore and Shields (1995) stress the key to the river restoration in the developed world is the partial recovery of some of the river's ecological values and functions in carefully selected reaches. We suggest that adaptive management of the existing LMR floodplain will enhance fisheries production, and concurrently provide opportunities to further explore the ecological function of temperate floodplain-river ecosystems. Specifically, strategies designed to detain and warm floodplain waters are needed to recouple the thermal and flood cycles. Such strategies should include maintaining or re-establishing connectivity of existing waterbodies within the leveed floodplain. During summer low-water stages, there are approximately 53 300 ha of lakes on the floodplain; however, less than 25% of these lakes remain connected to the river (Schramm *et al.*, 1999). Although important aquatic habitats, these lakes comprise a relatively small area of the LMR and are being steadily lost to sedimentation (Schramm, 2004). Thus, we suggest that restoration of ecological function may also require construction of new floodplain waterbodies. Although such management activities may seem ambitious or otherwise far-fetched, they would require only a small fraction of the resources that have been dedicated to construction projects necessary to maintain navigation and alleviate flooding in the lower Mississippi River-floodplain ecosystem.

ACKNOWLEDGMENTS

Assistance with fish collection and preparation and analysis spines was provided by Justin Hart, Rob Mayo, and Aaron Walters. David Galat and Steve Gutreuter provided useful input to the final manuscript. Funding for this study was provided by the U.S. Army Corps of Engineers Mississippi Valley Division and the U.S. Geological Survey Mississippi Cooperative Fish and Wildlife Research Unit.

REFERENCES

Baker JA, Kilgore KJ, Kasul RL. 1991. Aquatic habitats and fish communities in the Lower Mississippi River. *Reviews in Aquatic Sciences* **3**: 313–356.

Bayley PB. 1991. The flood pulse advantage and the restoration of river-floodplain ecosystems. *Regulated Rivers: Research & Management* **6**: 75–81.

Biedenharn DS, Watson CC. 1997. Stage adjustment in the lower Mississippi River, USA. *Regulated Rivers: Research & Management* **13**: 517–536.

Edds DR, Matthews WJ, Gelwick FP. 2002. Resource use by large catfishes in a reservoir: is there evidence for interactive segregation and innate differences? *Journal of Fish Biology* **60**: 739–750.

Eggleton MA. 2001. Catfish feeding ecology and bioenergetics in a large river-floodplain ecosystem. Doctoral dissertation, Mississippi State University: Starkville, Mississippi.

Eggleton MA, Schramm HL Jr. 2004. Feeding ecology and energetic relationships with habitat of blue catfish *Ictalurus furcatus* and flathead catfish *Pylodictis olivaris* in the lower Mississippi River, USA. *Environmental Biology of Fishes* **70**: 107–121.

Fremling CR, Rasmussen JL, Sparks RE, Cobb SP, Bryan CF, Claflin TO. 1989. Mississippi River fisheries: a case history. In *Proceedings of the International Large River Symposium*, Dodge DP (ed.). Canadian Special Publications in Fisheries and Aquatic Sciences 106; 309–351.

Goulding M. 1980. *The Fishes and the Forest*. University of California Press: Berkeley, California.

Gore JA, Shields FD Jr. 1995. Can large rivers be restored? *BioScience* **45**: 142–152.

Graham K. 1999. A review of the biology and management of blue catfish. In *Catfish 2000: Proceedings of the International Ictalurid Symposium*, Irwin ER, Hubert WA, Rabeni CF, Schramm HL Jr., Coon T (eds). American Fisheries Society: Bethesda, Maryland; 37–50.

Grubaugh JW, Anderson RV. 1988. Spatial and temporal availability of floodplain habitat: long-term changes at Pool 19, Mississippi River. *American Midland Naturalist* **119**: 402–411.

Gutreuter S, Bartels AD, Irons K, Sandheinrich MB. 1999. Evaluation of the flood-pulse concept based on statistical models of growth of selected fishes of the upper Mississippi River system. *Canadian Journal of Fisheries and Aquatic Sciences* **56**: 2282–2291.

Heiler G, Hein T, Schiemer F, Bornette G. 1995. Hydrological connectivity and flood pulses as the central aspects for the integrity of a river-floodplain ecosystem. *Regulated Rivers: Research & Management* **11**: 351–361.

Humphries P, King AJ, Koehn JD. 1999. Fish, flows and flood plains: links between freshwater fishes and their environment in the Murray-Darling River system, Australia. *Environmental Biology of Fishes* **56**: 129–151.

Jackson DC. 1999. Flathead catfish: biology, fisheries, and management. In *Catfish 2000: Proceedings of the International Ictalurid Symposium*, Irwin ER, Hubert WA, Rabeni CF, Schramm HL Jr., Coon T (eds). American Fisheries Society: Bethesda, Maryland; 23–36.

Junk WJ, Bayley PB, Sparks RE. 1989. The flood pulse concept in river-floodplain ecosystems. In *Proceedings of the International Large River Symposium*, Dodge DP (ed.). Canadian Special Publications in Fisheries and Aquatic Sciences 106; 110–127.

Lee DC. 1983. Growth of blue, channel, and flathead catfish in selected habitats of the lower Mississippi River. Master's thesis, University of Tennessee: Knoxville, Tennessee.

Mayo RM. 1999. Growth of blue catfish, channel catfish, and flathead catfish relative to latitude and physical characteristics of the lower Mississippi River. Master's thesis, Mississippi State University: Starkville, Mississippi.

Poff NL, Allan JD, Bain MB, Karr JR, Prestegaard KL, Richter BD, Sparks RE, Stromberg RC. 1997. The natural flow regime: a paradigm for river conservation and restoration. *BioScience* **47**: 769–784.

Rutherford DA, Kelso WE, Bryan CF, Constant GC. 1995. Influence of physicochemical characteristics on annual growth increments of four fishes from the lower Mississippi River. *Transactions of the American Fisheries Society* **124**: 687–697.

Schramm HL Jr. 2004. Status and management of fisheries in the Mississippi River. In *Proceedings of the Second International Symposium on the Management of Large Rivers for Fisheries* (Vol. 1), Welcomme R, Petr T (eds). RAP Publication 2004/16: Bangkok, Thailand; 301–333.

Schramm HL Jr., Eggleton MA, Mayo RM. 2000. Habitat conservation and creation: invoking the flood-pulse concept to enhance fisheries in the lower Mississippi River. *Polski Archiwum Hydrobiologii* **47**: 45–62.

Schramm HL, Eggleton MA, Minnis RB. 1999. Spatial analysis of floodplain habitat critical to lower Mississippi River fishes. Mississippi Cooperative Fish and Wildlife Research Unit: Mississippi State, Mississippi.

Schramm HL, Malvestuto SP, Hubert WA. 1992. Evaluation of procedures for back-calculation of lengths of largemouth bass aged by otoliths. *North American Journal of Fisheries Management* **12**: 604–608.

Sparks RE. 1995a. Need for ecosystem management of large rivers and their floodplains. *BioScience* **45**: 168–182.

Sparks RE. 1995b. Maintaining and restoring the ecological integrity of the Mississippi River: importance of floodplains and floodpulses. *Transactions of the North American Wildlife and Natural Resources Conference* **60**: 90–97.

Sparks RE, Nelson JC, Yin Y. 1998. Naturalization of the flood regime in regulated rivers. *BioScience* **48**: 706–720.

Stickney RR. 1988. *Culture of Nonsalmonid Freshwater Fishes*. CRC Press: Boca Raton, Florida.

Tockner K, Pennetzdorfer D, Reiner N, Schiemer F, Ward JV. 1999. Hydrological connectivity, and the exchange of organic matter and nutrients in a dynamic river-floodplain system (Danube, Austria). *Freshwater Biology* **41**: 521–535.

Tucker CS, Robinson EH. 1990. *Channel Catfish Farming Handbook*. Van Nostrand Reinhold Press: New York.

Ward JV, Stanford JA. 1995. Ecological connectivity in alluvial river ecosystems and its disruption by flow regulation. *Regulated Rivers: Research & Management* **11**: 105–119.

Weatherly AH, Gill HS. 1987. *The Biology of Fish Growth*. Academic Press: London.

Welcomme RL. 1979. *Fisheries Ecology of Floodplain Rivers*. Longman Press: London.

Welcomme RL. 1985. *River fisheries*. FAO (Food and Agriculture Organization of the United Nations) Fisheries Technical Paper 262.

Attachment D

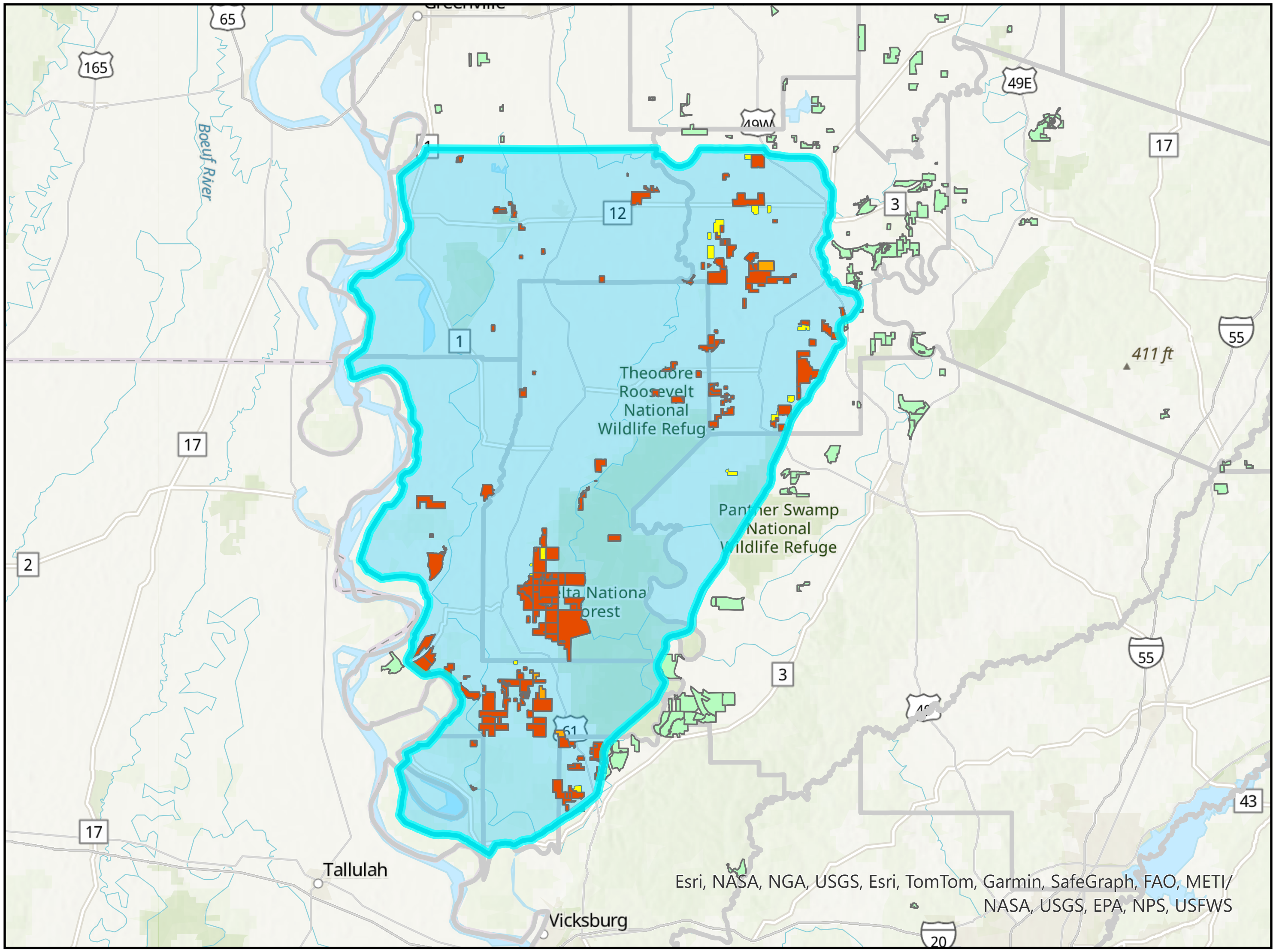
Comments on the Final Environmental Impact Statement for the Yazoo Backwater Area Water Management Project, November 2024

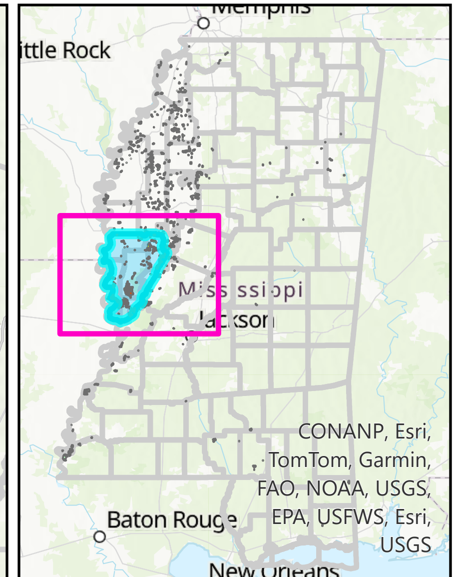
Submitted by

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

December 30, 2024

USDA NRCS -Mississippi, NRCS Easements in the Yazoo Backwater Area for Fiscal Year 2024





Legend

N

County

Easements in Yazoo Backwater Area

Program

- ACEP-WRE
- EWPP-FPE
- WRP

- Yazoo Backwater Area
- NRCS Easements

USDA Natural Resources Conservation Service
U.S. DEPARTMENT OF AGRICULTURE

USDA is an equal opportunity provider, employer, and lender.

December 30, 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: E*IS No. 20240224, Final, USACE, MS,* Yazoo Backwater Area Water Management Project

Dear Mr. Renacker:

On behalf of our more than 350,000 members and supporters, American Rivers is writing to express our opposition to the Final Environmental Impact Statement for the Yazoo Backwater Area Water Management Plan. We remain gravely concerned that the selected Alternative 3, and 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 is prohibited by the 2008 Clean Water Act § 404(c) Final Determination. Proceeding with this alternative sets a dangerous precedent for reversing decisions on highly impactful water resources projects.

The Environmental Protection Agency notes in their letter on the Final EIS dated December 20, 2024, that the estimated wetland functional losses of Alternative 3 will be 27,354 Average Annual Functional Capacity Units. This significant quantity of impacted wetlands is 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 Section 404(c) veto authority of the Clean Water Act[2] 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 are 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

[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] 42 U.S.C. § 1344(c).

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." [3] The veto prohibits a range of plans, including a 25,000 cfs pumping plant, determining that "the subsequent operation of pumping stations would result in unacceptable adverse effects on fishery areas and wildlife."[4]

In addition, the concerns raised in our previous comment letters remain, including concerns regarding the significant direct and indirect impacts of Alternative 3, the impacts on environmental justice communities, and the vulnerability of the operations plan to changes that will have increased impacts on community members, wetlands, and fish and wildlife populations.[5][6]

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.

Sincerely,

Eileen Shader

Eileen Shader, CFM
Senior Director, Floodplain Restoration

[3] 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
[4] ibid.
[5] American Rivers letter to USACE on the Notice of Intent submitted on August 7, 2023
[6] American Rivers letter to USACE on the Draft Environmental Impact Statement submitted on August 27, 2024

The Nature Conservancy

December 31, 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 Final 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 Final 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 Alternative 3 as the recommended Water Management Plan to alleviate chronic flooding and provide habitat benefits through structural and non-structural components.

We believe the proposed plan for Alternative 3 includes 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. This plan includes a suite of structural and nonstructural components including pump stations, seasonal pump operations, low flow wells, voluntary buyouts, and structural floodproofing.

Securing all compensatory mitigation sites prior to construction of the project ensures all environmental impacts are mitigated up front without the risk of being left incomplete. After

Post Office Box 2444
Madison, Mississippi 39130-2444

Tel: (601) 713-3355
Fax: (601) 510-3271
nature.org/mississippi

project completion, it is important to continue monitoring the pump station operations and analyze long-term efficiency to validate the project's successes. The USACE has outlined 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. The proposed solution provides significant flood risk reduction for communities and local economies while also minimizing impacts to the environment. Plans considered without structural components, due to their inability to reduce flooding from the landscape, were not practical and provided limited benefits to the region. The Conservancy supports moving forward with the water management plan associated with Alternative 3 that 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

Post Office Box 2444
Madison, Mississippi 39130-2444

Tel: (601) 713-3355
Fax: (601) 510-3271

nature.org/mississippi

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

OFFICE OF WATER

WASHINGTON, D.C. 20460

January 8, 2025

The Honorable Jaime A. Pinkham
Acting Assistant Secretary of the Army (Civil Works)
U.S. Department of the Army
108 Army Pentagon
Washington, D.C. 20310-0108

Dear Mr. Pinkham:

On November 29, 2024, the U.S. Army Corps of Engineers, Vicksburg District issued a Final Environmental Impact Statement for the Yazoo Backwater Area Water Management Project (2024 FEIS). The Recommended Plan described in the 2024 FEIS includes a proposed pumping project (2024 Plan for the Yazoo Pumps Project). Following the Corps' issuance of the 2007 Final Supplemental Environmental Impact Statement for the Yazoo Pumps Project (2007 FSEIS), the pumps project was the subject of a *Clean Water Act* Section 404(c) Final Determination issued by the U.S. Environmental Protection Agency in 2008 (2008 FD). In a letter dated November 19, 2024, you asked the EPA whether the 2008 FD applies to the 2024 Plan for the Yazoo Pumps Project.

Based on a comprehensive evaluation of the 2008 FD and the record for the 2008 FD, 2007 FSEIS and 2024 FEIS, the agency has concluded that the CWA Section 404 discharges from the 2024 Plan for the Yazoo Pumps Project are not prohibited by the 2008 FD. For the reasons discussed in Attachment A, the 2008 FD does not apply to the 2024 Plan for the Yazoo Pumps Project. This analysis is based on the 2024 Plan for the Yazoo Pumps Project as presented in the 2024 FEIS and assumes implementation of the Memorandums of Agreement referenced in Attachment A. This letter is limited to the 2024 Plan as proposed and does not address the applicability of the EPA's 2008 FD to any potential future plans, including modifications to the 2024 Plan, that the Corps may propose.

Also, as part of our review, the EPA separately evaluated and considered the proposed compensatory mitigation designed to offset the project's unavoidable impacts to wetlands and other aquatic resources, as well as fish and wildlife species, and finds that this mitigation is expected to reduce adverse effects to an acceptable level. Of particular importance is the commitment to purchase all necessary in-lieu fee program/mitigation bank credits and/or secure all Corps-constructed compensation sites prior to commencing any work in waters of the United States associated with the 2024 Plan. Any changes to the compensatory mitigation plan, including failure to purchase necessary in-lieu fee program/mitigation bank credits and/or secure Corps-constructed compensation sites prior to commencing work in waters of the United States, would raise serious questions regarding whether impacts will be reduced to an acceptable level and thus the EPA would consider the Plan for review pursuant to CWA Section 404(c).

The EPA appreciates the collaborative process pursued by the Corps in the development of the 2024 Plan, which we anticipate will provide significant flood risk reduction in the lower Mississippi Delta while avoiding, minimizing and effectively compensating for impacts to the region's important ecological resources.

If you have further questions regarding this letter, please contact me or your staff may contact Brian Frazer at (202) 566-1652 or frazer.brian@epa.gov.

Sincerely,

Bruno Pigott
Principal Deputy Assistant Administrator

ENCLOSURE

cc: Colonel Jeremiah A. Gipson, U.S. Army Corps of Engineers, Vicksburg District
Mike Oetker, Southeast Region, U.S. Fish and Wildlife Service
Jeaneanne M. Gettle, U.S. Environmental Protection Agency, Region 4

Attachment A

Detailed Analysis

This document includes four sections. Section I provides relevant background on *Clean Water Act* Section 404(c), flooding in the Yazoo Backwater Area, the 2007 Plan for the Yazoo Pumps Project, the EPA's 2008 CWA Section 404(c) Final Determination concerning the Yazoo Pumps Project (2008 FD),[1] the 2020 Plan for the Yazoo Pumps Project, and the 2024 Plan for the Yazoo Pumps Project proposed in the U.S. Army Corps of Engineers' 2024 Final Environmental Impact Statement for the Yazoo Backwater Area Water Management Project (2024 FEIS).[2] Section II provides the EPA's determination regarding the applicability of its 2008 FD to the 2024 Plan for the Yazoo Pumps Project. Section III discusses the proposed compensatory mitigation designed to offset the 2024 Plan's unavoidable impacts to wetlands and other aquatic resources, as well as fish and wildlife species. Section IV summarizes relevant conclusions.

I. Background

A. CWA Section 404

CWA Section 404 creates a program that regulates the discharge of dredged or fill material into waters of the United States through the specification of disposal sites. The statute prescribes roles for the EPA and the Corps to implement the CWA Section 404 program.

- Disposal sites may be specified in various ways, including through the Corps regulatory program or Civil Works program. *See* 33 U.S.C. § 1344; 40 C.F.R. § 230.2(a).
- Subject to CWA Section 404(c), CWA Section 404(b) directs the Secretary of the Army to apply environmental criteria developed by the EPA in specifying disposal sites for the discharge of dredged or fill material. These substantive regulatory criteria are known as the CWA Section 404(b)(1) Guidelines. The "Guidelines are applicable to the specification of disposal sites for discharges of dredged or fill material into waters of the United States." 40 C.F.R. § 230.2(a). The requirements of the Guidelines apply to both the Corps' Section 404 regulatory program decisions as well as to Corps Civil Works projects.

Section 404(c) states:

> "The Administrator is authorized to prohibit the specification (including the withdrawal of specification) of any defined area as a disposal site, and he is authorized to deny or restrict the use of any defined area for specification (including the withdrawal of specification) as a disposal site, whenever he determines, after notice and opportunity for public hearings, that the discharge of such materials into such area will have an unacceptable adverse effect on municipal water supplies, shellfish beds and fishery areas (including spawning and breeding areas), wildlife, or recreational areas. Before making such determination, the Administrator shall consult with the Secretary. The Administrator shall set forth in writing and make public his findings and his reasons for making any determination under this subsection."

[1] The 2008 FD is available at: https://www.epa.gov/sites/production/files/2015-05/documents/yazoo-final-determination_signed_8-31-08.pdf.
[2] The 2024 FEIS is available at: https://www.mvk.usace.army.mil/Missions/Programs-and-Project-Management/Yazoo-Backwater/.

Pursuant to Section 404(c), an action under this provision includes four key components: a prohibition, restriction, denial, and/or withdrawal (the 2008 FD includes a prohibition); the "defined area" subject to the prohibition; the materials subject to the prohibition (referred to below as the "prohibited discharges"); and the basis for the EPA determining that the discharge "will have an unacceptable adverse effect on municipal water supplies, shellfish beds and fishery areas (including spawning and breeding areas), wildlife, or recreational areas." The EPA's regulations implementing CWA Section 404(c) include a multi-step process to exercise this authority, including the issuance of a Proposed Determination, Recommended Determination, and Final Determination. 40 C.F.R. Part 231.

B. Flooding in the Yazoo Backwater Area

The Yazoo Backwater Area is situated between the Mississippi and Yazoo Rivers in west-central Mississippi immediately north of Vicksburg, Mississippi and has historically been subject to flooding during high flow events in the Mississippi River. Flood risk reduction for the entire Yazoo Backwater Area was authorized by the *Flood Control Act* of 1941. Since authorization and subsequent modification, the Corps has completed construction of extensive flood risk reduction features in the Yazoo Backwater Study Area, or YSA (Figures 1 and 2). This infrastructure has significantly reduced the frequency and duration of flooding in the YSA from the Mississippi and Yazoo Rivers 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 flow events in the Mississippi River. When the Mississippi River is experiencing a high flow event and the Steele Bayou Water Control Structure, or Steele Bayou WCS, is closed, rainfall that occurs within the YSA basin accumulates resulting in flooding within the YSA. This flooding is known as backwater flooding.

C. 2007 Yazoo Pumps Project

As described in a 2007 Final Supplemental Environmental Impact Statement (2007 FSEIS)[3] developed pursuant to the *National Environmental Policy Act*, the 2007 Yazoo Pumps Project was a Corps Civil Works project designed to address these backwater flooding concerns.
The 2007 FSEIS Recommended Plan for the Yazoo Pumps Project, referred to as "Plan 5," included a 14,000 cubic feet per second, or cfs, pumping station with a year-round pumping elevation of 87 feet National Geodetic Vertical Datum, or NGVD. The 2007 FSEIS Plan 5 was designed to pump flood water out of the YSA and into the lower Yazoo River when the Steele Bayou WCS is closed. As discussed above, when the Mississippi River is experiencing a high flow event and the Steele Bayou WCS is closed, rainfall that occurs within the YSA basin accumulates resulting in flooding within the YSA.

1. EPA's Section 404(c) review process

The 2007 FSEIS Plan 5 would have directly impacted approximately 43.6 acres of wetlands and other waters of the United States through the discharge of dredged or fill material associated with construction of the pumping station at the Steele Bayou site located adjacent to the Steele Bayou WCS (2007 FSEIS, Appendix 2, CWA Section 404(b)(1) Evaluation, pp. 2-3) (Figure 1). The secondary/indirect effects from operation of the 2007 Plan 5 pumping station would have adversely impacted

[3] The 2007 FSEIS is the first supplement to the 1982 Final Environmental Impact Statement for the Yazoo Pumps Project (1982 FEIS) and is available at: https://www.mvk.usace.army.mil/Missions/Programs-and-Project-Management/Project-Management/Yazoo-Backwater-Project/Yazoo-Backwater-Report/.

approximately 67,000 acres of wetlands in the Yazoo Backwater Area (2007 FSEIS Main Report, Table 17, pp. 1-20).

Because of concerns that the 2007 project's large-scale wetland impacts could result in extensive adverse impacts to the area's fish and wildlife resources, the EPA initiated the Section 404(c) review process in February of 2008. After consulting with the Corps and the Mississippi Board of Levee Commissioners (the local project sponsor) on potential opportunities to reduce project impacts, EPA Region 4 published its Proposed Determination in March 2008 for public comment and held a public hearing. After reviewing public input, EPA Region 4 submitted its Recommended Determination to EPA Headquarters in July of 2008.

2. 2008 FD findings

Unacceptable adverse effects

The 2007 FSEIS considered additional pumping station alternatives to Plan 5. These alternatives (i.e., Plans 3, 4, 6 and 7) would have adversely impacted between approximately 28,400 and 118,400 acres of wetlands. After the EPA initiated its Section 404(c) review in February of 2008, the Corps proposed two alternatives to Plan 5 to attempt to reduce project impacts to an acceptable level. One of these alternatives was Plan 6 from the 2007 FSEIS and the second was described by the Corps as a modification of Plan 6 (i.e., Modified Plan 6) which would have resulted in adverse impacts to between approximately 28,400 and 48,000 acres of wetlands (2008 FD, p. 13). Table 1 compares key features of the 2007 Plans prohibited by the 2008 FD including pumping capacities, pumping elevations, direct and secondary/indirect impacts to wetlands, non-structural features, compensatory mitigation and water control structure management.

The 2008 FD concludes that construction and operation of Plans 3 through 7 and Modified Plan 6 would dramatically alter the timing, and reduce the spatial extent, depth, frequency and duration of time project area wetlands flood (2008 FD, p. 72). The 2008 FD also concludes that the large-scale hydrologic alterations caused by Plans 3 through 7 and Modified Plan 6 would significantly degrade the critical ecological functions provided by at least 28,400 acres of wetlands in the Yazoo Backwater Area, including those functions that support wildlife and fisheries resources (2008 FD, p. 72). Thus, the 2008 FD finds that the discharge of dredged or fill material associated with Plans 3 through 7 and Modified Plan 6 would result in unacceptable adverse effects on fishery areas and wildlife because each of these alternatives would adversely impact at least 28,400 acres of wetlands in the Yazoo Backwater Area (2008 FD, pp. 72-73).

Compensatory mitigation and reforestation

The 2008 FD also evaluates the proposed compensatory mitigation and reforestation (i.e., a "nonstructural" component of the project) plans described in the 2007 FSEIS (Table 1), finding extensive deficiencies with the proposals. Together, the plans included 10,662 acres of compensation for the proposed project, 4,367 acres of compensation for impacts associated with already implemented aspects of related projects, and 40,571 acres of additional reforestation for a total of 55,600 acres of revegetated agricultural land without hydrologic restoration. Acquisition would have started two months after the Record of Decision was signed and continued for 14 years.

Deficiencies in the proposed compensatory mitigation and reforestation plans include an insufficient amount of compensation to offset impacts, inadequate restoration measures to offset functional impacts, lack of sufficient suitable (i.e., restorable) acreage available in the targeted area, failure to identify specific compensation and reforestation sites, and complete reliance on compensation and reforestation sites not yet acquired via purchase of conservation easements from willing landowners.

The EPA's unacceptable adverse effects determination was not ameliorated by the proposed, but deficient, compensatory mitigation and reforestation plans, because neither reduced the impacts of the listed Plans to acceptable levels (2008 FD, p. 73). Specifically, the 2008 FD "finds that the environmental benefits suggested by the FSEIS to accrue from the project's [reforestation] have not been substantiated." (2008 FD, p. 73). And the 2008 FD "finds that the Corps has not demonstrated that potential impacts of the Yazoo Backwater Area Project can be adequately mitigated to reduce the impacts to an acceptable level." (2008 FD, p. 73).

Water control structure management

The 2007 FSEIS includes a proposal to change the management of the Steele Bayou WCS to hold additional water within the YSA during certain times of the year when water levels are low in the Area's streams and other waters. The 2007 FSEIS describes this effort as a *water management feature* (see Table 1 for proposed elevations for holding water behind the Steele Bayou WCS). The 2008 FD considers this particular water management feature to be irrelevant for purposes of EPA's review of the Yazoo Pumps Project stating that "[o]peration of the Steele Bayou control gates to maintain water elevations and generation of the environmental benefits associated with this operation is not dependent upon construction of any pumping station." (2008 FD, p. 6).

Commitment to Further Collaboration

Recognizing the need for continued collaboration on a solution to address backwater flooding in the YSA, the 2008 FD states that the "EPA continues to support the goal of providing improved flood protection for the residents of the Mississippi Delta; however, it believes that this vital objective can be accomplished consistent with ensuring effective protection for the area's valuable natural resources. EPA is committed to participating in discussions with other federal and state agencies, and the public, concerning the best way to provide flood protection while protecting wetlands and other natural resources." (2008 FD, p. iv).

D. 2020 Yazoo Pumps Project

The combination of more frequent and significant flooding in the Yazoo Backwater Area; increased economic and safety concerns for the area's residents; and the availability of new and improved environmental and hydraulic data prompted the initiation of an updated evaluation of the 2007 Recommended Plan and in 2020, the Corps issued a second supplement to the 1982 FEIS.

This 2020 Final Supplemental Environmental Impact Statement (2020 FSEIS) relied heavily on the 2007 FSEIS.[4] Like the 2007 Recommended Plan, the 2020 Recommended Plan also consisted of a pump station with a maximum combined pumping capacity of 14,000 cfs and a year-round pumping elevation of 87.0 feet NGVD at the Steele Bayou gage. However, the location of the pumping station was moved to a site at Deer Creek, and changes were made to the proposed reforestation/conservation and compensatory mitigation measures. Prior to issuance of the 2020 FSEIS, the EPA provided the Corps with a letter dated November 30, 2020, that stated that the 2008 FD did not apply to the 2020 Recommended Plan for the Yazoo Pumps Project.

The 2020 FSEIS was filed with the EPA on December 11, 2020, and circulated for a final 30-day state and federal agency review and comment period. After a final review by other federal, state, and local agencies and the public, a ROD was signed on January 15, 2021. However, on January 12, 2021, four conservation groups challenged EPA's November 30, 2020, letter. *American Rivers, et al. v. EPA,* No.1:21-cv-00097 (D.D.C.). As part of this litigation, The EPA reviewed the November 2020 letter consistent with an Executive Order signed by President Biden on January 20, 2021. "Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis," 86 FR 7037. This involved a comprehensive review of the record of the 2008 FD, 2007 FSEIS, and 2020 FSEIS. Based on this review, the agency determined that it needed to reconsider the applicability determination in the November 30, 2020, letter and filed a motion for remand without vacatur of the determination in that letter. On October 4, 2021, the court granted the EPA's motion.

As discussed in its November 17, 2021 letter from EPA Assistant Administrator for the Office of Water, Radhika Fox, to Acting Assistant Secretary of the Army (Civil Works), Jaime Pinkham, based on a comprehensive evaluation of the 2008 FD and the associated record, the 2007 FSEIS, and the 2020 FSEIS, the EPA concluded that the 2020 Recommended Plan was 2007 FSEIS Plan 5 and involved discharges into the geographic area covered by the 2008 FD. Therefore, the EPA concluded that the 2020 Recommended Plan was prohibited by the 2008 FD.[5] As a result, the Corps withdrew the Record of Decision on December 11, 2021, and sought opportunities for continued agency discussions on alternative plans to address flooding concerns in the area.

E. 2023 Joint Memorandum of Collaboration

In January 2023, the U.S. Department of the Army (Civil Works) and the EPA signed a Joint Memorandum of Collaboration to continue to address flooding in the Yazoo Backwater Area. The memorandum stated that Army and the EPA "are committed to a collaborative and expeditious path forward to establish flood risk reduction solution(s) in the [Yazoo Backwater Area] that are compliant with the *Clean Water Act* (CWA) and all other applicable laws and regulations." The Joint Memorandum also stated that "[c]lose collaboration between the Agencies throughout the process will serve the federal government in meeting flood risk management objectives, fulfilling NEPA and CWA Section 404 requirements, addressing the needs of the affected communities, and reducing potential conflicts and delays with the implementation of the project." Although the U.S. Fish and Wildlife Service was not a

[4] The 2020 FSEIS is available at: https://www.mvk.usace.army.mil/Missions/Programs-and-Project-Management/Project-Management/Yazoo-Backwater-Project/Yazoo-Backwater-Report/.

[5] EPA's November 17, 2021 letter is available at: https://www.epa.gov/system/files/documents/2021-11/epa-reconsideration-of-november-30-2020-yazoo-letter.pdf.

signatory to the Joint Memorandum, they were subsequently included in the collaborative effort in recognition of their important role in the Yazoo Backwater Area.

The Joint Memorandum identified activities to help enable the Corps to deliver a proposed approach to flood risk reduction for the Yazoo Backwater Area by June 2023. Pursuant to the 2023 Joint Memorandum, the EPA worked collaboratively with the Corps and the USFWS as it developed its approach. The Corps, the EPA and the USFWS participated in joint public engagement sessions regarding the Corps' proposed approach on February 15, 2023, and May 4 and May 5, 2023. The Corps outlined its proposed approach in its July 2023 *Federal Register* Notice announcing its intent to prepare a new EIS for the Yazoo Backwater Area Water Management Project (88 FR 43101, July 6, 2023).

As part of the NEPA process, the EPA provided scoping comments to the Corps on August 7, 2023, and attended cooperating agency meetings beginning September 14, 2023. Following issuance by the Corps of the draft EIS on June 28, 2024, the EPA attended public meetings on the draft EIS on July 22 and July 23, 2024, and provided comments to the Corps on the draft EIS on August 27, 2024.

F. 2024 Yazoo Pumps Project

On November 29, 2024, the Corps issued the final EIS for its plan to address remaining backwater flooding concerns in the YSA (i.e., the 2024 FEIS), and this plan includes a new proposal for the Yazoo Pumps Project. According to the 2024 FEIS, the overall project purposes of the 2024 Plan are to provide significant flood risk reduction for communities in the YSA and the local economy while avoiding and minimizing impacts to important environmental resources. Components of the 2024 Plan are identified in Table 1 and include the following.

1. Pumping Station

To reduce flood stages across all frequency flood events in the YSA, the 2024 Plan includes a 25,000 cfs pump station at the Steele Bayou site located adjacent to the Steele Bayou WCS. To avoid and minimize adverse impacts on the environment and still meet the overall project purposes, the pump operation plan manages water levels at 90.0 feet National Geodetic Vertical Datum of 1929 (NGVD29)[6] at the Steele Bayou gauge during crop season (25 March – 15 October) and up to 93.0 feet NGVD29 at the Steele Bayou gauge during non-crop season (16 October – 24 March).

2. Water Control Structure Management

In its current state, the YSA is an altered system due to the Mississippi Mainline levee and Yazoo Backwater levee and outlet structures limiting inflow of water from the Yazoo-Mississippi Rivers. During potential flood-prone periods with rising Mississippi and Yazoo Rivers, the 1985 Water Control Manual for the operation of Steele Bayou WCS allows 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. However, in the absence of a pumping station, the practice has been to close the gate at lower elevations. Implementation of the 2024 Plan and its pumping station will allow full utilization of the 1985 Water Control Manual including allowing 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 which will promote fish passage. During low-water periods, consistent

[6] The is consistent with the datum used in the 2007 FSEIS.

with the water control structure operation plan, the Steele Bayou WCS is operated to maintain water elevations between 68.5 and 70.0 feet NGVD29, and this will be continued.

3. Compensatory Mitigation

According to the 2024 FEIS (Appendix F-3 – Wetlands), direct impacts associated with the construction of the pumping station would result in impacts to 432 acres of wetlands which equates to the loss of 1,884 Average Annual Functional Capacity Units, or AAFCUs, using the Hydrogeomorphic assessment method (Smith and Klimas 2002,[7] Smith and Lin 2007[8]). The 2024 FEIS finds that the secondary/indirect impacts associated with operation of the pumping station, as proposed, are not likely to convert wetlands in the YSA to non-wetlands; however, the reductions in flood frequency and duration resulting from implementation of 2024 Plan are expected to impact wetland function. Implementation of the 2024 Plan is estimated to result in the loss of 25,470 AAFCUs spread across approximately 92,867 acres of wetlands in the YSA (Table 1). Estimated functional impacts of the 2024 Plan for wetlands, aquatic resources/fisheries, waterfowl and wildlife as well as required mitigation are summarized in Table 2.

To fully offset these wetland impacts as well as estimated impacts to aquatic resources/fisheries, waterfowl, and wildlife, the 2024 FEIS indicates that the Corps will purchase credits totaling 27,354 AAFCUs (1,884 + 25,470 AAFCUs) from the Mississippi Delta – In-Lieu Fee Program operated by Ducks Unlimited. The FEIS estimates that approximately 5,722 acres of wetland restoration would be necessary to generate these credits and that these offsets would be provided through wetland restoration within the post-project 2- and 5-year floodplains with the following caveat: to provide the necessary offsets for impacts to fisheries spawning and rearing habitat, approximately 3,106 acres of this wetland restoration would be provided within the post-project 2-year floodplain (see Table 2). In addition, the Corps will purchase credits totaling 352 Average Annual Habitat Units, or AAHUs, from the Mississippi Delta – In-Lieu Fee Program to offset remaining impacts to shorebirds. Importantly, the Corps has committed to purchasing all necessary credits and, if necessary, securing all Corps-constructed compensatory mitigation sites, prior to any work in waters of the United States associated with the 2024 Plan.

4. Memorandums of Agreement

Another important component of the 2024 Plan is the inclusion of three Memorandums of Agreement between the Corps, the EPA and the USFWS.

- **Water Control Plan MOA:**[9] An agreement on the final water control operations which provides that the Corps will obtain concurrence from the EPA prior to implementing any changes to or non-

[7] Smith, R.D., and C.V. Klimas. 2002. A regional guidebook for applying HGM approach to assessing wetland functions of selected regional wetlands subclasses, Yazoo basin, Lower Mississippi River alluvial valley. U.S. Army Corps of Engineers ERDC/EL TR-02- 4.

[8] Smith, R.D., and J. Lin. 2007. Yazoo Backwater Project: Assessing Impacts to Wetland Functions and Recovery of Wetland Functions in Restoration Areas. U.S. Army Engineer Research and Development Center, Waterways Experiment Station, Environmental Laboratory, Vicksburg, MS. Report to the U.S. Army Corps of Engineers – Vicksburg District.

[9] Memorandum of Agreement Between the U.S. Army Corps of Engineers, the U.S. Environmental Protection Agency and the U.S. Fish and Wildlife Service Concerning the Yazoo Backwater Water Management Plan Pump and Water Control Structure

emergency deviations from the pump operation plan and water control structure operation plan described in the 2024 FEIS.

- **Compensatory Mitigation MOA:**[10] An agreement on procedures for the review, approval and oversight of the compensatory mitigation for the 2024 Plan. As part of this MOA, proposed work will not commence in waters of the United States until the Corps has obtained concurrence from the EPA on the mitigation plan for each compensatory mitigation component and all in-lieu fee program/mitigation bank credits have been purchased and/or Corps-constructed compensatory mitigation sites have been secured.
- **Monitoring and Adaptive Management MOA:**[11] An agreement on procedures for the development, review, approval and oversight of long-term monitoring efforts designed to help identify actual project-induced, landscape-scale changes and thereby inform adaptive management decisions regarding ongoing implementation of water management and compensatory mitigation efforts in the YSA.

II. Applicability of the 2008 FD to the 2024 Yazoo Pumps Project

This section sets forth the results of the EPA's determination regarding the applicability of its 2008 FD to the 2024 Plan for the Yazoo Pumps Project. As discussed below, the EPA has concluded that its 2008 FD does not apply to the 2024 Plan for the Yazoo Pumps Project proposed in the 2024 FEIS.

In determining the applicability of the 2008 FD to the 2024 Plan, the EPA has carefully evaluated the text of the 2008 FD, its administrative record, the EPA's 2021 findings and the administrative records for the 2007 FSEIS and 2024 FEIS. The agency has also consulted the relevant text of CWA Section 404(c) to inform our understanding of the scope of the 2008 FD. For the reasons below, the EPA has concluded that the 2024 Plan is not subject to the prohibition contained in the 2008 FD.

As described above, an action under CWA Section 404(c) includes four key components: a prohibition, restriction, denial, and/or withdrawal (the 2008 FD includes a prohibition); the "defined area" subject to the prohibition; the materials subject to the prohibition (referred to below as the "prohibited discharges"); and the basis for the EPA determining that the discharge "will have an unacceptable adverse effect on municipal water supplies, shellfish beds and fishery areas (including spawning and breeding areas), wildlife, or recreational areas" (in this case unacceptable adverse effects on fishery areas and wildlife).

If the EPA finds that the proposed discharges of dredged or fill material are not in the "defined area" subject to the prohibition or that the proposed discharges are not the prohibited discharges, the 2008

Operation Plans, dated November 25, 2024. Available at: https://www.mvk.usace.army.mil/Missions/Programs-and-Project-Management/Yazoo-Backwater/FileId/401737/.

[10] Memorandum of Agreement Between the U.S. Army Corps of Engineers, the U.S. Environmental Protection Agency and the U.S. Fish and Wildlife Service Concerning the Yazoo Backwater Water Management Plan Compensatory Mitigation Plan, dated November 25, 2024. Available at: https://www.mvk.usace.army.mil/Missions/Programs-and-Project-Management/Yazoo-Backwater/FileId/401738/.

[11] Memorandum of Agreement Between the U.S. Army Corps of Engineers, the U.S. Environmental Protection Agency and the U.S. Fish and Wildlife Service Concerning the Yazoo Backwater Water Management Plan Monitoring and Adaptive Management Plan, dated November 25, 2024. Available at: https://www.mvk.usace.army.mil/Missions/Programs-and-Project-Management/Yazoo-Backwater/FileId/401739/.

FD does not apply, regardless of the level of estimated impacts.[12] Thus, the applicability of the 2008 FD to the 2024 Plan for the Yazoo Pumps Project turns on the second and third of the statutory components: i.e., does the project lie within the "defined area" and involve "prohibited discharges" identified by the 2008 FD. After evaluation, the agency concludes the answer to the first question is yes, and the answer to the second question is no. The EPA's basis for its conclusions is explained below.

A. The 2024 Yazoo Pumps Project is located within the "defined area" subject to the prohibition in the 2008 FD

The EPA's November 17, 2021, letter referenced above includes a detailed discussion of the "defined area" subject to the prohibition in the 2008 FD. As discussed in that letter, the "defined area" is the boundary of the 2007 FSEIS Yazoo Backwater Project Area. According to the 2007 FSEIS, the "Yazoo Backwater Project Area, as depicted on Plate 4-1, lies in west-central Mississippi between the mainline Mississippi River east bank levee and the hill line on the east. The triangular shaped area extends northward about 65 miles to the latitude of Hollandale and Belzoni, Mississippi, and comprises about 1,446 square miles (926,000 acres)." (2007 FSEIS Main Report, p. 20).

The 2007 Recommended Plan for the Yazoo Pumps Project was located at the Steele Bayou site adjacent to the Steele Bayou WCS within the Yazoo Backwater Project Area. The 2024 Plan for the Yazoo Pumps Project is also proposed to be located at the Steele Bayou site adjacent to the Steele Bayou WCS. Thus, the proposed discharges of dredged or fill material associated with the 2024 Plan are in the "defined area" subject to the prohibition.

B. Discharges from the 2024 Yazoo Pumps Project are not prohibited by the 2008 FD

The 2008 FD does not prohibit all CWA Section 404 discharges in the defined area; rather it prohibits "the discharge of dredged or fill material for the purpose of construction of [2007] FSEIS Plans 3 through 7, and Modified Plan 6." (2008 FD, p.73).[13] The record, as described below, supports the conclusion that the 2024 Plan for the Yazoo Pumps Project is not one of the prohibited plans and thus does not include prohibited discharges. The 2008 FD states the following:

> "The adverse effects associated with the prohibited projects are the result of a combination of operational factors including the capacity of the pumping station and its associated pump-on elevations. While this Final Determination prohibits the construction of FSEIS Plans 3 through 7, and Modified Plan 6, the data supporting this Final Determination indicates that derivatives of the prohibited projects that involve only small modifications to the operational features or

[12] Nothing in such a finding limits the EPA's discretion to initiate a new CWA Section 404(c) review process.

[13] The proposed scope of the discharges subject to the prohibition narrowed between the Proposed Determination and Recommended Determination and the scope identified in the Final Determination. The scope of the prohibited discharges in the Proposed Determination included those "for the purpose of constructing the Yazoo Backwater Area Project's pumping station or any other pumping proposal in the Yazoo Backwater Area that would involve significant adverse impacts on waters of the United States." (73 FR 14819). Similarly, the scope of the prohibited discharges in the Recommended Determination included those "for the purpose of construction of the proposed project or any similar pump project in the Yazoo Backwater Area that would result in an unacceptable adverse effect to the waters of the United States." (2008 RD, p.69).

> location of these proposals would also likely result in unacceptable adverse effects and would generate a similar level of concern and review by EPA." (2008 FD, p.73).

As the EPA indicated in its November 17, 2021, letter from EPA Assistant Administrator for the Office of Water, Radhika Fox, to Acting Assistant Secretary of the Army (Civil Works), Jaime Pinkham, referenced above, this text was included in the 2008 FD to provide advance notice to the Corps regarding what to expect if it asks the EPA to modify the 2008 FD based on "only small modifications to the operational features or location" of the pumping station. Namely that small modifications to the pumping station that do not result in significant reductions in the environmental impacts of the project "would generate a similar level of concern and review by EPA" and any requests to modify the 2008 FD based on such inconsequential project changes "would also likely result in unacceptable adverse effects" and thus, would likely not support such modification requests to the 2008 FD. Thus, the 2008 FD prohibits discharges from the specified plans and future plans with the exact same operational features (e.g., pump capacity and pump on elevation) as the 2007 Plans as well as future plans with "small modifications" to the operational features of the 2007 Plans.

The 2024 Plan includes modifications to the operational features that qualify as more than small modifications from the plans prohibited by the 2008 FD. It includes a 25,000 cfs pumping station and different seasonal variations in the pump on elevation that allow water to reach a maximum of 93.0 feet (significantly higher than any of the plans prohibited by the 2008 FD). Because the 2024 Plan does not contain the same operational features (e.g., pump capacity and pump on elevation) as the plans prohibited by the 2008 FD, and because the operational features include more than small modifications to the operational features of the plans prohibited by the 2008 FD (Table 1), the 2024 Plan is not prohibited by the 2008 FD. These differences were designed by the Corps to help ensure that the 2024 Plan would be less environmentally damaging than those prohibited by the 2008 FD. Importantly, the Corps has signed an MOA with the EPA and the USFWS that provides assurances that the water control plans will not change without concurrence from the EPA.

<u>1. The pumping elevations for the 2024 Plan are considerably different from the plans prohibited by the 2008 FD</u>

The YSA is home to highly functional, forested riverine wetlands, known as riverine backwater wetlands, which require periodic flooding at intervals at least every one to five years to deliver their full suite of wetland ecological functions (Smith and Klimas 2002). According to Smith and Klimas (2002), riverine backwater wetlands are found in the 5-year floodplain which the 2024 FEIS estimates to be bounded by the 92.8-foot elevation. Pumping elevations proposed in the prohibited plans never exceeded 91 feet and thus would have significantly reduced or in some cases eliminated the periodic flooding necessary for these wetlands to deliver their full suite of wetland ecological functions. According to the 2024 FEIS, to minimize impacts to riverine backwater wetlands, it was recognized that some level of periodic flooding would need to be provided to the entire 5-year floodplain. As a result, the 2024 Plan allows flooding to reach the 93.0-foot elevation during the non-crop season (16 October - 24 March) (2024 FEIS, Section 3).

The 2024 FEIS (Appendix F-3 – Wetlands) demonstrates how the higher pumping elevations in the 2024 Plan make it less environmentally damaging than the 2007 Plans. The plans evaluated in the 2007 FSEIS used a narrow wetland assessment area that only evaluated the impacts of those plans to the subset of wetlands in the 2-year flood frequency that experience at least 14 consecutive days of flood inundation. Using the same narrow assessment area, the 2024 FEIS compares the wetland impacts of the 2024 Plan to both 2007 Plan 5 (the 2007 Recommended Plan) and 2007 Plan 7 (the least environmentally damaging of the plans prohibited by the 2008 FD) and finds that implementation of the 2024 Plan would reduce total wetland functional losses by 74 percent compared with 2007 Plan 5 and 10 percent compared with 2007 Plan 7 (2024 FEIS, Appendix F-3 – Wetlands, p.24 and Table 99). These levels of reductions in impacts demonstrate that the changes to the operational features, and specifically the pumping elevations, associated with the 2024 Plan are more than "small modifications."

<u>2. The pumping capacity for the 2024 Plan is distinguishable from the plans prohibited by the 2008 FD</u>

To ensure that the pump station would be able to effectively manage water elevations at 90.0 feet during crop seasons and up to 93.0 feet during non-crop seasons, varying pump capacities were considered. The 2024 FEIS evaluates the following pump capacities: 14,000 cfs; 17,500 cfs; 20,000 cfs; 22,100 cfs; and 25,000 cfs (2024 FEIS, Appendix A – Engineering Report, Table 2-26). However, pumping capacities less than 25,000 cfs were screened out for two reasons:

- First, they would not allow the Corps to effectively manage water levels to 93 feet. These lower pump capacities would require pumping to be initiated at much lower elevations to manage water at 93 feet. Initiating pumping at lower levels would increase impacts to riverine backwater wetlands by reducing the frequency and duration of flooding for these wetlands located between 90 and 93 feet. (2024 FEIS, Section 3).
- Second, they would not allow the Corps to fully utilize the 1985 Water Control Manual which allows rising water from the Mississippi and Yazoo Rivers to flow into the YSA up to an elevation of 75 feet. The smaller pump capacities would require the Corps to close the gates at lower water elevations to preserve more storage capacity in the YSA sump areas in the event of rainfall occurring within the YSA drainage during periods of backwater flooding. The current practice of closing the gates at lower water elevations would continue existing conditions that limit fish passage. (2024 FEIS, Section 3).

All the 2007 Plans prohibited by the 2008 FD included a 14,000 cfs pumping station. The 2024 FEIS makes clear that this size pumping station would not be able to deliver the environmental benefits associated with the higher pumping elevations and the proposed management of the Steele Bayou WCS that are central to the 2024 Plan. The size of the pump itself and its purpose to deliver these levels of environmental benefits demonstrate that the change to the pumping capacity associated with the 2024 Plan is more than a "small modification."

<u>3. Water Control Plan MOA provides assurances that neither the pump operation plan nor the water control structure operation plan will change without concurrence from EPA</u>

Concerns have been raised that the Corps could unilaterally change aspects of the pump operation plan or water control structure operation plan for the Recommended Plan described in the 2024 FEIS, as it is not uncommon for the Corps to make changes in its water control plans. However, in this case, the Corps has entered into an MOA with the EPA and the USFWS that assures, among other things, that the Corps will obtain concurrence from the EPA that the adverse environmental effects of changes or deviations have been adequately mitigated before the Corps implements any changes or non-emergency deviations to the pump operation plan or water control structure operation plan for the Recommended Plan described in the 2024 FEIS. The assurances provided in the Water Control Plan MOA are an important consideration in this determination.

III. Evaluation of proposed compensatory mitigation

Even though the 2024 Plan represents a less environmentally damaging project than the plans prohibited by the 2008 FD, the direct wetland impacts of the 2024 Plan are greater than those of the 2007 Plans, and the total wetland impacts (direct and secondary/indirect) are within the range discussed in the 2008 FD. The record, as described below, explains why the estimated wetland impacts of the 2024 Plan remain high despite the environmental improvements in the project and why the proposed compensatory mitigation is expected to reduce these impacts to an acceptable level.[14]

A. Effects of increasing pumping capacity and broadening the impact assessment area

1. Direct Impacts to Wetlands

The lower the pumping elevations, the greater the secondary/indirect impacts to wetlands because of reductions in the frequency and duration of backwater flooding in the YSA necessary to sustain riverine backwater wetland functions (Smith and Klimas 2002). As discussed above, according to the 2024 FEIS, to effectively manage floodwaters at the higher pumping elevations contemplated in the 2024 Plan (and thereby reduce secondary/indirect impacts to wetlands), a larger pumping capacity than was proposed in 2007 (i.e., 14,000 cfs) was necessary. According to the 2024 FEIS, a pumping capacity of 25,000 cfs is necessary to effectively manage floodwaters at the higher pumping elevations in the 2024 Plan, and this larger capacity pumping station requires a larger project construction footprint. Thus, to effectuate a large reduction in the secondary/indirect impacts to wetlands, an increase in direct wetland impacts was necessary. This explains why the direct impacts to wetlands have increased from the loss of 38 acres/240 AAFCUs for the 2007 Recommended Plan to the loss of 432 acres/1,884 AAFCUs for the 2024 Plan.

2. Secondary/Indirect Impacts to Wetlands

Despite implementing higher pumping elevations which are designed to reduce the secondary/indirect impacts of the pumping station to wetlands, the 2024 FEIS reports that the 2024 Plan would result in secondary/indirect impacts to wetlands comparable to those reported for the plans prohibited by the

[14] Under CWA Section 404(c), the EPA has discretionary authority to prohibit, restrict, deny and/or withdraw the use of any defined area as a disposal site "whenever" it determines that the discharge of dredged or fill material will have an unacceptable adverse effect on statutorily enumerated aquatic resources. The statutory standard does not direct the EPA to consider mitigation when determining what constitutes an unacceptable adverse effect, nor restrict the EPA to exercising its authority unless and until the EPA has before it a Corps permit identifying required mitigation. The EPA's regulations provide that "[i]n evaluating the unacceptability of such impacts, consideration should be given to the relevant portions of the section 404(b)(1) guidelines." (40 CFR 231.2). The EPA may consider mitigation a relevant portion of the CWA Section 404(b)(1) guidelines when certainty regarding mitigation exists, such as when a permit has been issued with an approved compensatory mitigation plan or, as here, where the Corps plans to proceed with a Civil Works Project authorized under 33 CFR 335.2 in lieu of a permit and has committed to implement a specific compensatory mitigation plan and agreed, among other things, to obtain EPA concurrence on any changes to that plan.

2008 FD (i.e., the loss of approximately 25,470 AAFCUs affecting approximately 92,867 acres of wetlands). The reason for this similarity is that the 2024 FEIS uses a larger assessment area that provides a more comprehensive estimate of wetland impacts than the narrow assessment area used in the 2007 FSEIS.

As discussed above, the 2007 FSEIS evaluates secondary/indirect impacts to wetlands in a narrow assessment area, identifying impacts to just the subset of wetlands in the 2-year flood frequency that experience at least 14 consecutive days of flood inundation (an assessment area including approximately 139,000 acres of potential wetland area according to the 2024 FEIS, Appendix F-3 – Wetlands, Table 29[15]). In response to critiques from the EPA, the USFWS and others on the 2007 FSEIS, the 2024 FEIS evaluates secondary/indirect impacts to wetlands that experience any period of flood inundation in the entirety of the 5-year flood frequency, a larger geographic area more likely to provide a comprehensive estimate of these wetland impacts (an assessment area including approximately 330,000 acres of potential wetland area according to the 2024 FEIS, Appendix F-3 – Wetlands, Table 29). This more thorough accounting of impacts to riverine backwater wetlands consistent with the Hydrogeomorphic assessment method helped the Corps to design a compensatory mitigation strategy that would fully offset anticipated wetland impacts.

B. Compensatory mitigation is expected to reduce adverse effects to an acceptable level

As discussed above, the 2008 FD identified extensive deficiencies with the compensatory mitigation proposed to address the impacts of the 2007 Plans (2008 FD, pp. 60-62). The 2008 FD raised concerns that impacts were underestimated for several reasons. First, impact assessment areas for wetlands and fisheries/aquatic resources were overly narrow and failed to capture functional losses to aquatic and terrestrial resources that occurred outside the boundaries of the 14-day flood duration interval within the 2-year floodplain. Additionally, the 2007 FSEIS did not ensure that compensatory mitigation sites would be located where they would continue to receive flooding at a frequency and duration sufficient to support the suite of ecological functions provided by riverine backwater wetlands. The 2008 FD determined that reforesting lands within areas potentially impacted by the proposed project was insufficient to compensate for project impacts. Numerous other deficiencies identified in the 2008 FD include lack of sufficient suitable (i.e., restorable) acreage available in the targeted area, the lack of hydrologic restoration measures to offset functional losses caused by reduced flood frequency and duration, failure to identify specific compensation sites, and complete reliance on compensation sites not yet acquired via purchase of conservation easements from willing landowners. The 2008 FD notes that this reliance on future willing sellers would likely result in a noncontiguous patchwork of fragmented compensation sites unlikely to deliver the ecological benefits predicted by the 2007 FSEIS. Accordingly, the 2008 FD "finds that the Corps has not demonstrated that potential impacts of the Yazoo Backwater Area Project can be adequately mitigated to reduce the impacts to an acceptable level." (2008 FD, p. 73).

The Corps designed its 2024 Plan to address these deficiencies. The 2024 FEIS' use of a larger assessment area (i.e., the entirety of the 5-year flood frequency) for its wetlands and fisheries/aquatic resources impacts assessments (Appendix F-3 – Wetlands and Appendix F-6 – Aquatic Resources/Fisheries) ensures that likely impacted resources are fully assessed (2024 FEIS, p. iii). The

[15] This value reflects the sum of potential wetland areas in the 2-year flood frequency interval that are flooded at 5 percent or greater duration intervals.

2024 FEIS also commits to ensuring that all compensatory mitigation sites will be located where they will continue to receive flooding at a frequency and duration sufficient to adequately support target ecological resources. As previously noted, all wetland compensation would be located within the post-project 2- and 5-year floodplains, and all necessary offsets for impacts to fisheries spawning and rearing habitat would be located within the post-project 2-year floodplain (2024 FEIS, p. 181). These changes ensure that the project impacts are accounted for, and sufficient compensation is being required to offset impacts to wetlands and the fish and wildlife resources that depend on them.

In addition, the higher pumping elevations of the 2024 Plan ensure that there is sufficient suitable (i.e., restorable) acreage available in the targeted area since larger portions of the YSA will remain below the pumping elevations as compared to the 2007 and 2020 Recommended Plans (2024 FEIS, Appendix F-3 – Wetlands p. 21). Finally, the use of the Mississippi Delta – In-Lieu Fee Program will ensure that regulatory requirements for mitigation planning are being addressed and that compensation sites are appropriately sized and located to deliver anticipated ecological benefits (2024 FEIS, pp. 179-183). As part of the Interagency Review Team that oversees the work of this in-lieu fee program, the EPA will be closely involved in the review and oversight of mitigation project implementation by the in-lieu fee program.

Most importantly, the Corps' commitment to purchase all necessary in-lieu fee program credits prior to any work in waters of the United States associated with the 2024 Plan ensures that appropriate compensatory mitigation sites will be secured, and environmental benefits will accrue on those sites before any impacts from the proposed project occur (2024 FEIS, p. 181 and Compensatory Mitigation MOA, p. 1). Fulfilling this commitment to fully compensate for the 2024 Plan's impacts in advance of proposed discharges of dredged or fill material will ensure timely and effective compensation so that the 2024 Plan would not exacerbate cumulative wetland impacts in the YSA and the Lower Mississippi River Alluvial Valley (2024 FEIS, Appendix I, pp. 30-32).

The Compensatory Mitigation MOA associated with the 2024 Plan includes further assurances that its compensatory mitigation will be timely and effective in addressing anticipated project impacts, including a commitment that the Corps will obtain concurrence from the EPA on any changes to the compensatory mitigation plan prior to any work in waters of the United States associated with the 2024 Plan.

Similarly, the Monitoring and Adaptive Management MOA includes important agreements among the Corps, the EPA and the USFWS on procedures for the development, review, approval, and oversight of long-term monitoring efforts designed to help identify actual project-induced, landscape-scale changes and thereby inform adaptive management decisions regarding ongoing implementation of water management and compensatory mitigation efforts in the YSA.

The USFWS has also evaluated the proposed compensatory mitigation plan. As discussed in its December 10, 2024, final *Fish and Wildlife Coordination Act* Report for the proposed project, the USFWS finds that the proposed compensatory mitigation would fully offset impacts to wetlands as well as estimated impacts to aquatic resources/fisheries, waterfowl and wildlife.

For these reasons, the EPA finds that the proposed compensatory mitigation plan is expected to reduce the adverse effects of the 2024 Plan to an acceptable level.

IV. Conclusions

Based on a comprehensive evaluation of the 2008 FD and the record for the 2008 FD, 2007 FSEIS and 2024 FEIS, the agency has concluded that the CWA Section 404 discharges from the 2024 Yazoo Pumps Project are not prohibited by the 2008 FD. Therefore, the 2008 FD does not apply to the 2024 Plan for the Yazoo Pumps Project. This analysis is based on the 2024 Plan for the Yazoo Pumps Project as presented in the 2024 FEIS and assumes implementation of the Memorandums of Agreement referenced above. This letter is limited to the 2024 Plan as proposed and does not address the applicability of the EPA's 2008 FD to any potential future plans, including modifications to the 2024 Plan, that the Corps may propose.

Also, as part of our review, the EPA separately evaluated and considered the proposed compensatory mitigation designed to offset the project's unavoidable impacts to wetlands and other aquatic resources, as well as fish and wildlife species. Although the estimated impacts for the 2024 Plan remain high due in part to the broader scope of the impact assessment area and the larger project construction footprint associated with the proposed pumping station (which is necessary so the greater pumping capacity can deliver the environmental benefits discussed above), the proposed compensatory mitigation is expected to reduce adverse effects to an acceptable level. Of particular importance is the commitment to purchase all necessary in-lieu fee program/mitigation bank credits and/or secure all Corps-constructed compensation sites prior to commencing any work in waters of the United States associated with the 2024 Plan. Any changes to the compensatory mitigation plan, including failure to purchase necessary in-lieu fee program/mitigation bank credits and/or secure Corps-constructed compensation sites prior to commencing work in waters of the United States, would raise serious questions regarding whether impacts will be reduced to an acceptable level and thus the EPA would consider the Plan for review pursuant to CWA Section 404(c).

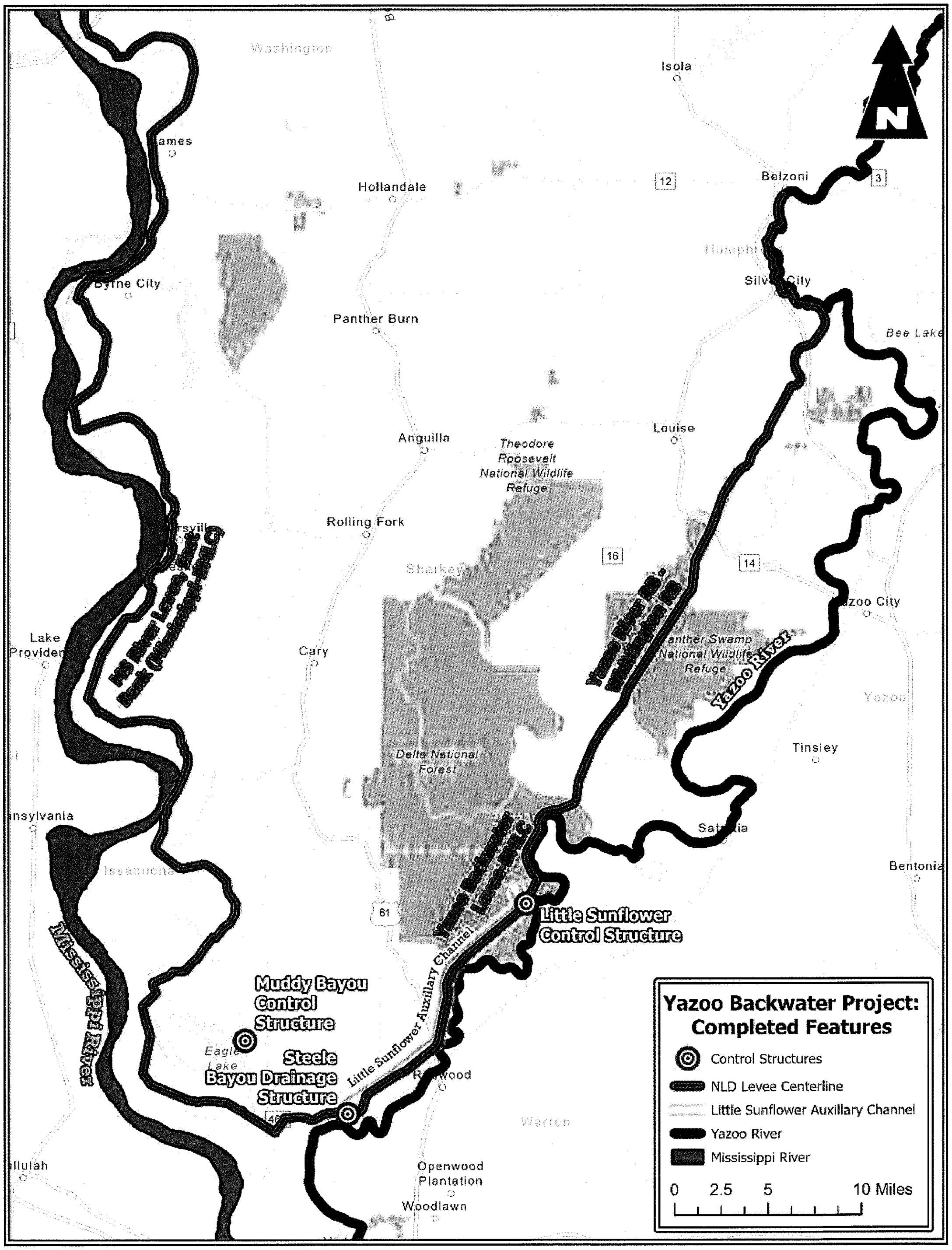


Figure 1. Completed features of the Yazoo Basin, Yazoo Backwater, Mississippi, Project (Yazoo Backwater Project). Figure obtained from the 2024 FEIS (Figure 1-2).

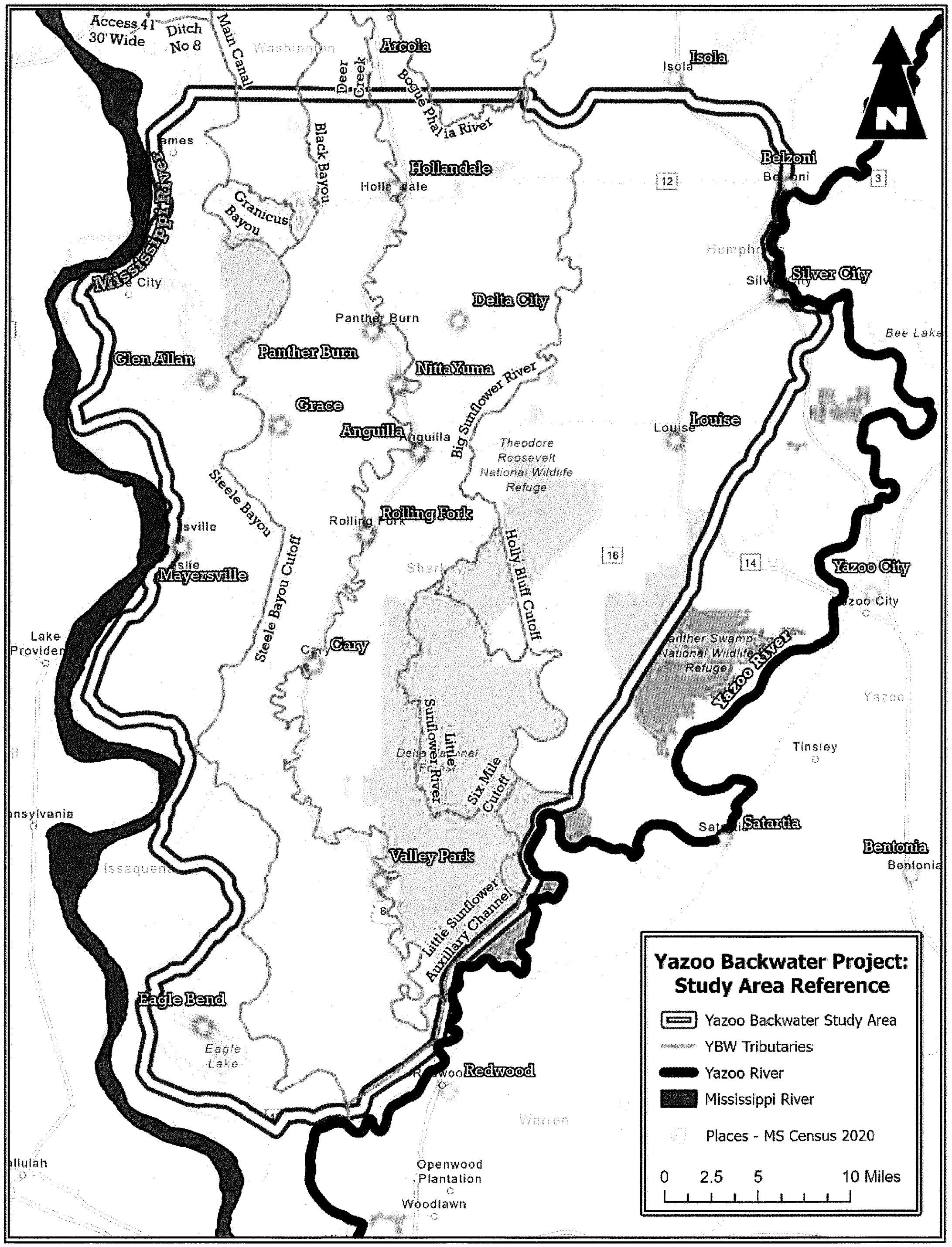


Figure 2. Yazoo Backwater Study Area (YSA). Figure obtained from the 2024 FEIS (Figure 1-1).

Table 1. Comparison of Yazoo Pump Plans prohibited in the 2008 Final Determination and proposed 2024 Pump Plan[a].

	2007 Plan 3	2007 Plan 4	2007 Plan 5	2007 Plan 6	2007 Plan 6 Modified	2007 Plan 7	2024 Plan
Pump Station Capacity (cfs[b])	14,000	14,000	14,000	14,000	14,000	14,000	25,000
Crop Season Pump Elevation (NGVD[c])	80.0’	85.0’	87.0’	88.5’	88.5’	91.0’	90.0’
Crop Season Date	1 MAR to 31 OCT	N/A	N/A	N/A	1 MAR to 31 OCT	N/A	25 MAR to 15 OCT
Non-Crop Season Pump Elevation (NGVD)	85.0’	85.0’	87.0’	88.5’	91.0’	91.0’	93.0’
Non-Crop Season Date	1 NOV to 28 FEB	N/A	N/A	N/A	1 NOV to 28 FEB	N/A	16 OCT to 24 MAR
Wetland Direct Impacts (acres)	38	38	38	38	38	38	432
Wetland Direct Impacts (AAFCUs[d])	-240	-240	-240	-240	-240	-240	-1,884
Wetland Indirect Impacts using 2007 Assessment Area (acres)	118,486	101,629	66,945	48,066	28,408 to 48,066[e]	28,408	Not available
Wetland Indirect Impacts using 2007 Assessment Area (AAFCUs)	-43,990	-28,132	-14,188	-9,300	-3,949 to -9,300[e]	-3,949	-1,881
Wetland Indirect Impacts using 2024 Assessment Area (acres)	Not available	Not available	Not available	Not available	Not available	Not available	92,867
Wetland Indirect Impacts using 2024 Assessment Area (AAFCUs)	Not available	Not available	Not available	Not available	Not available	Not available	-25,470
Nonstructural: Acquisition of Structures	N/A	N/A	N/A	N/A	N/A	N/A	Voluntary below 93.0’
Nonstructural: Voluntary Acquisition of Agricultural land (acres)	0	Up to 37,200[f]	Up to 55,600[f,g]	Up to 81,400[f]	Up to 81,400[f]	Up to 124,400[f]	Up to 11,816 at or below 2-yr floodplain and up to 27,675 between 2-yr and 5-yr floodplain

	2007 Plan 3	2007 Plan 4	2007 Plan 5	2007 Plan 6	2007 Plan 6 Modified	2007 Plan 7	2024 Plan
Compensatory Mitigation (acres)	53,363	27,230	15,029[h,i]	6,913[h]	9,156[h]	0	5,722[j]
Compensatory Mitigation Acquisition	Willing sellers; Easement	Willing sellers; Easement	Willing sellers; Easement	Willing sellers; Easement	Willing sellers; Fee Title or Easement	N/A	Purchase ILF credits
Timing of Compensatory Mitigation Acquisition	N/A	N/A	15,029 acres secured prior to operation of pumps	N/A	N/A	N/A	All credits secured prior to any work in WOTUS
Water Control Structure Management	Hold water 70.0 to 73.0' during low-water periods	Hold water 70.0 to 73.0' during low-water periods	Hold water 70.0 to 73.0' during low-water periods	Hold water 70.0 to 73.0' during low-water periods	Hold water 70.0 to 73.0' during low-water periods	Hold water 70.0 to 73.0' during low-water periods	Allow water up to 75.0' during high-water events
Interagency MOAs – between Army, EPA, and USFWS	N/A	N/A	N/A	N/A	N/A	N/A	1) Water Control Manual 2) Mitigation 3) Monitoring and Adaptive Management

[a] Sources 2007 FSEIS Table SEIS-12, Table SEIS-21, pages SEIS-43 to 52, Table 10-20, and materials provided by the Corps at the February 29, 2008, meeting with EPA Region 4 as well as 2024 FEIS Section 3 and Wetlands Appendix Tables 53, 92, 98, and 99.
[b] Cubic feet per second.
[c] National Geodetic Vertical Datum.
[d] Average Annual Functional Capacity Units
[e] In 2008, the Corps indicated that it had not calculated this estimate but that its value would fall between the impact estimates for FSEIS Plans 6 and 7.
[f] Total includes historic and current compensatory mitigation.
[g] The EPA views this number to be 40,571 acres of reforestation because the 55,600-acre figure includes 10,662 acres of compensation for the proposed project as well as 4,367 acres of compensation for impacts associated with already implemented aspects of related projects. Acquisition would have started 2 months after the Record of Decision was signed and continued for 14 years.
[h] These totals were provided by the Corps in the materials they shared at the February 29, 2008, meeting with EPA Region 4.
[i] Minimum amount of acreage required prior to operation of the pumps.
[j] In addition, the Corps proposes to offset the loss of approximately 352 Average Annual Habitat Units (AAHUs) for shorebirds (i.e., through the establishment of approximately 400 additional acres of managed wetlands).

Table 2. Estimated functional impacts and mitigation required for 2024 Plan. Values obtained from the 2024 FEIS (Table 6.1).

Assessment	2024 FEIS Reference	2024 Recommended Plan	
		Functional Impacts	Mitigation Required (acres)
Wetlands	Appendix F-3	27,354 AAFCU[a]	5,722
Aquatic Resources and Fisheries	Appendix F-6	3,851 ADFA[b]	3,106
Waterfowl	Appendix F-5	196,721 Annual DUD[c]	338
Terrestrial Wildlife - Migratory Landbirds (Prothonotary Warbler, Kentucky Warbler, Wood Thrush, Acadian Flycatcher)	Appendix F-4, Sub-appendix A	694 AAHU[d]	1,056
Terrestrial Wildlife - Shorebirds	Appendix F-4, Sub-appendix B	352 AAHU	403
Terrestrial Wildlife - Great Blue Heron	Appendix F-4, Sub-appendix C	698 AAHU	776 to 2,742[e]

[a] Average Annual Functional Capacity Units.
[b] Average Daily Flooded Acres.
[c] Annual Duck-Use-Days.
[d] Average Annual Habitat Units.
[e] Varies depending on proximity to existing nesting colonies and foraging habitat, see 2024 FEIS, Appendix F-4, Sub-appendix C, Table C-5.