Mississippi Valley Division,
Regional Planning and Environment Division South

Pearl River Basin Federal Flood Risk Management Project, , Mississippi

Appendix F-Mitigation Requirements

June 2024

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Mitigation Requirements
Pearl River Flood Risk Management Project

1. Overview

This document outlines the unavoidable habitat impacts and terrestrial as distinct from aquatic habitat mitigation requirements associated with the Pearl River Flood Risk Management (PR FRM) Project. A project specific mitigation plan will be developed during pre-construction engineering and design (PED) and included in a subsequent NEPA document(s). An Interagency Mitigation Team (IMT), which includes the US Fish and Wildlife Service (the Service), US Army Corps of Engineers Vicksburg District (MVK), Rankin and Hinds (non-federal interest (NFI)) and Mississippi Department of Wildlife, Fisheries, and Parks (MDWFP), will collaborate to complete detailed mitigation plan during PED. This mitigation plan will include all of the components set forth in laws, guidance, policy, and regulations. These components include an inventory and categorization of ecological resources, significant net losses, mitigation planning objectives, land considerations, potential mitigation strategies, alternative mitigation plans, costs of mitigation plan increments and alternatives, incremental costs, plan selection considerations, a recommended compensatory mitigation plan, implementation risks, criteria for determining ecological success, and a monitoring and adaptive management plan. No construction activities would begin prior to completion and approval of a mitigation plan as habitat mitigation is to occur prior to or concurrent with project construction.

The IMT determined that the nonstructural plan would not incur any impacts that would require habitat mitigation.

2. Coordination and Collaboration

Development of a mitigation plan involves extensive coordination and collaboration with the state and federal natural resource agencies, landowners, the NFI, and the public. An IMT has been developed and the team has contributed expertise and information to support the identification of impacts, potential mitigation strategies, and the future development of compensatory habitat mitigation plan alternatives. The views of resource agencies and others will be considered in the development of the draft and final recommended plan. These organizations will be offered an opportunity to continue to play a role in the design and implementation phases of the mitigation work when the PR FRM project is funded for implementation.

The cooperating and participating agencies are listed below. An interagency coordination meeting will be held to comply with the provisions of Section 1005 of the Water Resources Reform and Development Act of 2014. The meeting will afford agencies an opportunity to learn about the project and to provide input into the study.

- Rankin Hinds Pearl River Flood & Drainage Control District
- Environmental Protection Agency (EPA) Region 4

- Mississippi Department of Environmental Quality (MDEQ)
- Federal Emergency Management Agency (FEMA) Region IV
- Mississippi Department of Wildlife Fisheries and Parks (MDWFP)
- Mississippi Department of Marine Resources (MDMR)
- Mississippi Natural Resources Conservation Service (MNRCS)
- LA Department of Wildlife and Fisheries (LDWF)
- LA Department of Environmental Quality (LDEQ)
- Louisiana Department of Natural Resources (LDNR)
- Louisiana Coastal Protection and Restoration Authority (CPRA)
- U.S. Fish and Wildlife Service Jackson, MS District
- USFWS Lafayette, LA, District
- Mississippi Department of Archives & History

Public input is being sought during interagency meetings, public scoping meetings, and during review of the draft EIS. Comments from the public related to habitat impacts and mitigation will be considered in the development of subsequent NEPA document(s) as developed.

3. Inventory and Categorize Ecological Resources

Fish and wildlife habitat within the study area includes the Pearl River main stem and tributaries, the Ross Barnett Reservoir, a number of oxbow lakes formed by channel cutoffs resulting from prior channelization of the River, and several other smaller lakes or ponds. Many of the oxbow lakes and sloughs are associated with forested wetland ecosystems dominated by hardwoods interspersed with cypress-tupelo brakes. In addition, upland habitats are present on the higher elevations that contain both pine and mixed pine and hardwood timber stands. There are several areas located throughout the study area that have been converted to more early successional scrub-shrub (S-S) and emergent habitat types as a result of timber harvesting activities and floodway management. This forested wetland complex, in association with the river and its other aquatic habitats, provides habitat for many fish and wildlife species, resulting in a high species diversity.

The IMT has relied heavily on previous reports and documents for existing conditions and habitat resources found in the project areas. Sources of habitat data include information from resource agencies, published reports, and agency records. Table 1 describes how each data source could be used in developing the mitigation plan.

Table 1 - Data Sources

Year	Source of Information	Information	Use in Mitigation Planning
2014	Rankin-Hinds Pearl River Flood and	Habitat Evaluation Procedures (HEP)	Identification of impacts to specific species.

	Drainage Control District	Report Rankin-Hinds County Mississippi Flood Damage Reduction Project	
2020	USFWS	Fish and Wildlife Coordination Act Report Pearl River Basin, Mississippi Federal Flood Risk Management Project, Hinds and Rankin Counties, MS	Identification of habitat types and locations in the study area. Identification of impacts to habitat types in study area. Identification of mitigation strategies.
2023	USACE	Regulatory In-lieu fee and Bank Information Tracking System (RIBITS)	Identification of available mitigation bank credits.
2019	USFWS	Biological Opinion	Identification of habitat types and locations in the study area. Identification of impacts to habitat types in study area. Identification of mitigation strategies.

The habitat types within the project areas include mixed forested wetlands, emergent wetlands, mixed S-S wetlands, mixed upland forests, upland S-S, grassland, evergreen forest, and riverine. Table 2 shows the habitat resources in the project areas and the type of impact to the resource. These resources are recognized as significant across institutional, public, and technical perspectives.

Table 2 - Ecological Resources Within the project areas

Habitat	Type of Impact
Emergent wetland/palustrine	Direct due to excavation and fill
Lacustrine	Direct due to excavation and fill

Mixed forested wetland	Direct due to excavation and fill
Mixed S-S Wetland	Direct due to excavation and fill
Riverine	Direct and indirect due to excavation and weir
Upland Evergreen Forest	Direct due to fill
Upland Mixed Forest	Direct due to excavation and fill
Upland S-S	Direct due to excavation and fill

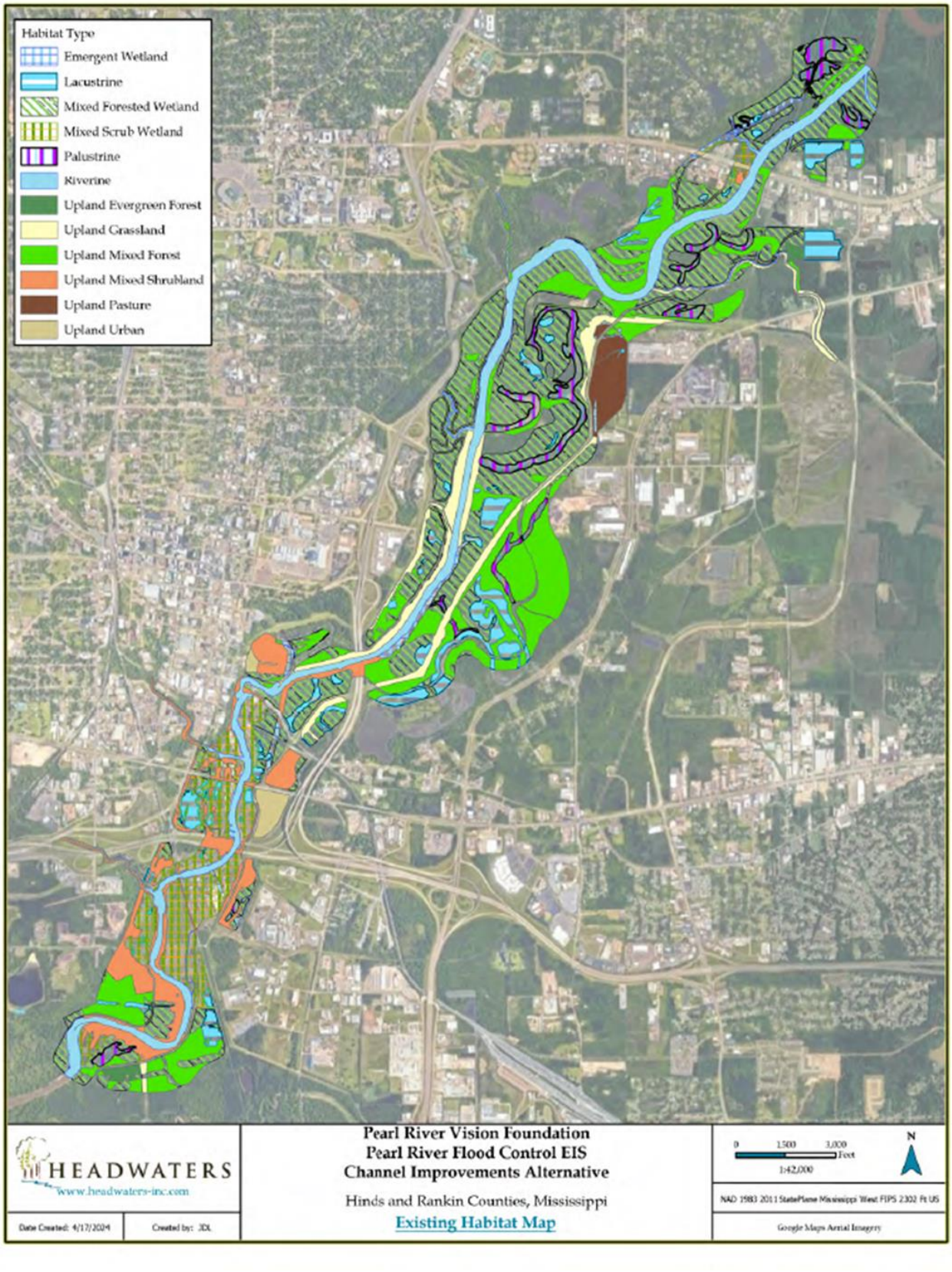
The Pearl River flows through the project areas (see Figure 1). It provides in-stream habitat for a variety of fish, mollusks, amphibians, and reptiles. Other wildlife, including mammals, and birds use the river for watering and foraging. Several listed and proposed species, the threatened Gulf sturgeon, the threatened ringed sawback (map) turtle, the proposed threatened Pearl River map turtle, the proposed threatened alligator snapping turtle, and the proposed threatened Louisiana pigtoe mussel are found in parts of the river. Alt C includes construction of a weir with a low-flow gate structure and excavating the floodplain extending from River Mile (RM) 284.0 to RM 293.5 (approximately 9.5 miles) with ranging widths of 400 to 2,000 feet. This would widen the footprint of the Pearl River in this area and would create a lake of approximately 2,562 acres. This conversion would eliminate riverine habitat that many aquatic species depend on. The CTO includes construction of a weir with a low-flow gate structure and excavating the floodplain extending from RM 285 to RM 294 (approximately 9 miles) with ranging widths of 500 to 2,600 feet. This would widen the footprint of the Pearl River in this area and would create a lake of approximately 1,706 acres. This conversion is likely to eliminate riverine habitat that many aquatic species depend on. For this draft, a conservative approach is being taken, and the IMT is assuming the CTO would convert the riverine system within the project area to a lake system. Velocity analysis, like that conducted for Alternative C, is being conducted to better understand the potential impact of the CTO on the riverine system. Additional analyses will be performed in PED to evaluate the heightened risk of invasive species introductions in this shallow lake system, the risk of Harmful Algal Blooms (HABs) and combined risks to listed and other aquatic species.

Forested wetlands are a significant natural resource in the project area. Forested wetland ecosystems dominated by hardwoods interspersed with cypress-tupelo brakes are found in

areas along the Pearl River. Deciduous and evergreen trees fill the landscape and herbaceous vegetation grows in areas with open canopy. Wildlife, including mammals, birds, amphibians, and reptiles use the forest habitat. These animals may be resident or transient depending on the species. Seasonal rainfall flooding plays a role in habitat composition associated with tolerance of rapid rises and short duration high flows down the river. Hurricanes and tropical storms occasionally impact the area with high winds and heavy rainfall. Alt C would remove approximately 1,374 acres of forested wetlands and 710 acres of forested uplands while the CTO alternative would remove approximately 744 acres of forested wetlands and 223 of forested uplands due to excavation and fill activities.

In addition to bottomland hardwood and cypress-tupelo habitat, smaller areas of upland hardwoods, mixed hardwood-pine woodlands, S-S, pasture, and cropland are present in the study area. S-S habitat often occurs along the flanks of ridges, the edge of riverbanks and oxbows, and in the southern portion of the basin in marshes altered by spoil deposition or drainage projects. Typically, S-S habitat is bordered by marsh or open water at lower elevations and by developed areas, cypress-tupelo swamp, or bottomland hardwoods at higher elevations. Figure 1 shows the different habitat types and where they occur in the project area.

Figure 1 – Habitat in the Project Area


Habitat Type
Emergent Wetland
Lacustrine
Mixed Forested Wetland
Mixed Scrub Wetland
Palustrine
Riverine
Upland Evergreen Forest
Upland Grassland
Upland Mixed Forest
Upland Mixed Shrubland
Upland Pasture
Upland Urban
HEADWATERS
www.headwaters-inc.com
Pearl River Vision Foundation
Pearl River Flood Control EIS
Channel Improvements Alternative
Hinds and Rankin Counties, Mississippi
Existing Habitat Map
0 1,500 3,000 Feet
1:42,000
N
NAD 1983 2011 StatePlane Mississippi West FIPS 2302 Ft US
Google Maps Aerial Imagery
Date Created: 4/17/2024
Created by: JDL

4. Determine Significant Net Losses

The interagency team determined that using the 2014 HEP analysis results (Annex F1) would be acceptable for identifying impacts on fish and wildlife habitat. In some areas, natural succession and landscape changes have occurred , since the 2014 analysis, and the Alt C footprint has been reduced resulting in a reduction of forested uplands impacts. Therefore, the 2014 HEP acreages are not consistent with the existing habitat acreages. Table 3 displays a comparison of the 2014 HEP analysis habitat acres to the existing habitat acres.

Table 3 Habitat Impact Changes from 2014 to Current

Habitat Type	Acres of Impact 2014 HEP	Description of Habitat Change	Current Acres of Impact
Emergent Wetlands	59		315
Lacustrine/Open Water	200		200
BLH wet	912	No longer lumped together as forested wetlands	762
Swamp			150
Scrub-shrub wetlands	256	Converted to Emergent for conveyance improvement	147
Riverine	287		287
Forested Uplands	536	Reduction in project footprint reduced acres of impact	696
palustrine	147	Palustrine acres re-categorized to S-S wetlands	0
upland evergreen	14		14
upland grassland	152		152
upland pasture	54		54
upland shrub	209	Natural succession to forested uplands	0

Numbers are approximated and have been rounded for simplicity.

The IMT met on several occasions to discuss habitat impacts and assumptions to apply to mitigation. The following assumptions were agreed upon by the IMT.

- Upland grassland and pasture would not be mitigated.
- Lacustrine habitat would be self-mitigating by both Alt C and Alt CTO with a weir.
- S-S wetlands would be mitigated with BLH.
- Upland evergreen would be mitigated with forested uplands.
- Emergent wetlands are not a habitat that naturally exists in this area. The emergent wetlands that currently exist are due to maintenance activities (such as mowing and herbicide treatment) within the area. Therefore, emergent wetland impacts would be mitigated with BLH.
- Acres of impact due to CTO would be determined by overlaying the CTO footprint with the habitat map.
- AAHUs of impact due to CTO would be calculated by applying the percent acres decrease by habitat type from Alt C to CTO to the AAHUs of Alt C (see Table 4)
- Riverine impacts would be displayed as acres until PED when appropriate obligate riverine species would be used to determine units of impact.
- It is assumed that any recreational features implemented by the NFI would occur within the already impacted footprint (i.e. fill areas) and would not impact any of the mitigation features required for threatened and endangered species under the Endangered Species Act.

Model outputs measure habitat value in "average annual habitat units" (AAHUs). Table 4 displays the impacts for each of the habitat types based on the IMT assumptions. The AAHUs of riverine impacts have not been adequately determined at this time and are therefore displayed in acres impacted. During PED, HEP modeling protocols would be use with agreed upon Habitat Suitability Index (HIS) models for appropriate obligate riverine species to determine the AAHUs of riverine habitat impacted and required for mitigation.

Table 4 Impacts to be Mitigated Based on IMT Assumptions

Habitat	Alt C Acres of Impact	CTO Acres of Impact	% decrease	Alt C AAHUs	CTO AAHUs
Lacustrine/Open Water	200	81	60%	1,232	497
BLH wet	1,224	689	44%	3,011	1,695
Swamp	150	55	63%	368	135
Forested Uplands	710	223	69%	2,733	859

Riverine*	287	232			

Numbers are approximated and have been rounded for simplicity.
*Riverine impacts are not finalized at this time as the number of AAHUs impacted has not been adequately quantified.

If the CTO without a weir were to be implemented, the riverine impacts of approximately 232 acres would no longer be incurred and so riverine mitigation would not be necessary. The terrestrial impacts would still be realized and so BLH, swamp, and forested uplands mitigation would still be required. Additionally, approximately 497 AAHUs of lacustrine habitat would require mitigation as there would be no weir to create a lake and therefore would not be self-mitigating.

5. Mitigation Requirements

The number of AAHUs impacted per habitat type is equivalent to the number of AAHUs required for mitigation. AAHU's and acres, however, do not have a one-to-one equivalency. Actual acreage required for mitigation, therefore, is determined based on the habitat quality of the mitigation site and the mitigation strategy to be implemented. That being said, as stated above, neither riverine AAHUs nor mitigation requirements have been quantified at this time. During PED appropriate obligate riverine species would be used to run HEP to quantify the habitat units, as distinct from acreage, required for mitigation of riverine impacts.

As discussed above, the IMT agreed on combining some habitat types for mitigation purposes. The following mitigation requirements would be satisfied in the Pearl River watershed, and the IMT determined that lacustrine impacts would be self-mitigated with Alt C and Alt CTO with a weir. If the CTO alternative without a weir were to be implemented, lacustrine habitat would need to be mitigated. It should be repeated that during PED, to inform development of a detailed mitigation plan, the habitat models would need to be revisited to determine the units of impact for each habitat type and the mitigation strategy for each.

Alt C

- Compensate for the loss of 3,011AAHUs BLH
- Compensate for the loss of 368 AAHUs swamp
- Compensate for the loss of 2,733 AAHUs forested uplands
- Compensate for the loss of 287 acres riverine habitat

Alt CTO with a weir

- Compensate for the loss of 1,695 AAHUs BLH wet
- Compensate for the loss of 135 AAHUs swamp
- Compensate for the loss of 859 AAHUs forested uplands
- Compensate for the loss of 232 acres riverine habitat

Alt CTO without a weir

- Compensate for the loss of 497 AAHUs of lacustrine habitat

- Compensate for the loss of 1,695 AAHUs BLH wet
- Compensate for the loss of 135 AAHUs swamp
- Compensate for the loss of 859 AAHUs forested uplands

6. Land Considerations

The NFI has identified lands that could be used to satisfy all, or a portion of, the terrestrial mitigation needs. These lands are within the PR basin and are available for acquisition. The IMT continues to assess the lands identified to determine what mitigation strategies could be implemented and how much of the mitigation need would be satisfied. The mitigation strategies and locations of riverine mitigation have not yet been identified. During PED, habitat modeling would be conducted using appropriate obligate riverine species to determine units of riverine impact, and mitigation planning to identify mitigation strategies and locations.

7. Potential Mitigation Strategies

Planning strategies are different means employed to develop a plan to achieve a project goal. The use of one or more strategies helps planning teams focus on an approach for developing a plan. For mitigation planning work, strategies may range from the purchase of mitigation bank credits to the construction of a project or projects to achieve the objectives and compensate for unavoidable impacts to habitat. Strategies may also involve different approaches to site selection such as the use of public lands or identification of contiguous sites that would potentially enhance wildlife corridors or expand wildlife pockets. In addition, implementation guidance for the Water Resources Development Act of 2016, Section 1163 requires the Corps of Engineers to consider mitigation bank credits or in-lieu fee programs where appropriate. Consideration of these options as mitigation strategies may be helpful when available. Strategies that may be considered for this mitigation project are described below. These, and other yet to be identified strategies may be considered in any combination to achieve full compensation for impacts to each habitat type. Further planning and analysis would be completed during PED to determine which strategies, stand alone or combined, would fully compensate for habitat impacts.

Terrestrial Habitats

- Purchase of mitigation bank credits. Commercial mitigation banks sell credits for mitigation work performed at an approved mitigation site. The banks are approved and legally bound through banking instruments that hold the bank owners to certain standards of performance and reporting. The use of mitigation banks for a project may offer advantages to the government and non-federal sponsor by reducing performance risk and eliminating project specific requirements for operations and maintenance work and development of monitoring and adaptive management plans.

- Construction of habitat restoration projects. Habitat restoration could be accomplished by converting open water or low-lying areas into swamp or converting agricultural or fast lands into BLH, swamp, or upland forests.

• Construction of habitat enhancement projects. Habitat enhancement could be accomplished by the reduction of invasive species to no more than 5% coverage and select removal of undesirable species followed by planting of required native species (BLH, swamp, upland forest) composition within the overstory canopy. The conversion of a degraded or undesirable forest (i.e. pine plantation) into native BLH, swamp, or upland forests.

• Construction of habitat preservation projects. Preservation would consist of no prescribed treatment other than purchasing land of suitable in-kind habitat, perpetually protecting the land to include adaptive management, and monitoring to ensure the species integrity of these areas.

Riverine Habitat

- Purchase of mitigation bank credits. Commercial mitigation banks sell credits for mitigation work performed at an approved mitigation site. The banks are approved and legally bound through banking instruments that hold the bank owners to certain standards of performance and reporting. The use of mitigation banks for a project may offer advantages to the government and non-federal sponsor by reducing performance risk and eliminating project specific requirements for operations and maintenance work and development of monitoring and adaptive management plans.

- Removal of obsolete aquatic barriers.

- Hydrological enhancement through replacement of existing undersized and damaged culverts with larger culverts and riprap or replacement of functional aquatic barriers with arch span culverts.

- Opening historically lost habitat.

- Connecting occupied and suitable unoccupied habitat.

- Creating nesting, breeding, and spawning habitat or refugia.

- Streambank stabilization.

- Increasing (enhancing) habitat quality and minimizing threats.

Pearl River Basin, Mississippi, Federal Flood Risk Management Project

Annex F1 - Habitat Evaluation Procedures (HEP) Report

June 2024

Habitat Evaluation Procedures (HEP) Report

Rankin-Hinds Pearl River Flood and Drainage Control District

Rankin-Hinds County Mississippi Flood Damage Reduction Project

October 2014

HEADWATERS INC.
NATURAL RESOURCES CONSULTING

RANKIN-HINDS COUNTY, MISSISSIPPI FLOOD DAMAGE REDUCTION PROJECT

DRAFT EVALUATION OF IMPACTS TO TERRESTRIAL AND AQUATIC HABITATS RESULTING FROM ALTERNATIVES FOR THE RANKIN-HINDS COUNTY, MISSISSIPPI FLOOD DAMAGE REDUCTION STUDY

INTRODUCTION

BACKGROUND AND OBJECTIVES

The Habitat Evaluation Procedures (HEP) (U.S. Fish and Wildlife Service (FWS), 1980a, 1980b) were used to quantify the potential impacts of Rankin-Hinds County, Mississippi Flood Damage Reduction Study. The study area includes parts of both Hinds, and Rankin Counties, Mississippi. Major tributaries of the Pearl River within the study area include Eubanks Creek, Hanging Moss Creek, Lynch Creek, Purple Creek, Three-Mile Creek and Town Creek. The study area utilized is located within the Jackson Metropolitan Area and is primarily affected by headwater flooding caused by the Pearl River. Headwater flooding is caused by unusually heavy and intense rainfall events over the upper Pearl River Basin and above the Ross Barnett Reservoir located at the northern extreme of the study area. HEP was utilized to evaluate potential terrestrial and aquatic habitat impacts that could be anticipated from the construction of the proposed channel improvements plan and the proposed levee plan.

HEP is a habitat based evaluation system that allows one to estimate current habitat conditions, predict future conditions, compare project alternatives and devise mitigation strategies. HEP was developed as an assessment tool that focuses on habitat variables verses efforts to directly sample animal populations within a proposed project area. The HEP analysis completed for the Pearl River Flood Damage Reduction Study area was completed in a manner to provide a sufficient level of evaluation of the potential impacts to terrestrial habitats as a result of the proposed alternatives and provide an assessment tool to facilitate comparisons with the Channel Improvement Plan and the Levee Plan. For the purposes of the overall National Environmental Policy Act (NEPA) Environmental Impact Statement (EIS), these proposed flood damage reduction alternatives are referred to as Alternative C and Alternative B, respectively.

The basic objectives of the HEP analysis prepared for the proposed Rankin-Hinds County, Mississippi Flood Damage Reduction Project study area were to

determine the pre-project or baseline habitat suitability for the selected wildlife species as "target species" for each habitat found within the study area and to provide an estimation of potential impacts to each of the "target species" as a result of the construction of the proposed Rankin-Hinds County, Mississippi Flood Damage Reduction Plan. It is also the objective of this analysis to develop potential mitigation measures or design modifications that will help offset unavoidable habitat losses if possible. Only the direct impacts associated with the two proposed structural alternatives for the Rankin-Hinds County, Mississippi Flood Damage Reduction Plan were evaluated. These direct impacts included land clearing, channel dredging and/or excavation, weir and levee construction and long-term maintenance needs. The direct impacts also include areas that have been identified as disposal/fill areas for the dredge and/or excavation material. Impacts associated with the construction of interior collector ditches, gated drainage structures within the proposed levee segments and pumping plants along the levee segments were not included in this assessment except to the extent that these features could result in potential impacts to the Pearl River tributary streams with the exception of Richland Creek.

OVERVIEW OF HEP

HEP is a method which can be used to document the quality and quantity of available habitat for selected wildlife species. The evaluation process provides basic information for use in two (2) general types of wildlife habitat comparisons, the relative value of different areas at the same point in time; and the relative value of the same area at future points in time. By combining the two (2) types of comparisons, the impact of the proposed or anticipated land and water use changes on wildlife habitat can be quantified. For this project, the assessment was completed for both aquatic and terrestrial target species covering the full extent of the affected habitat types associated with the proposed structural alternatives.

HEP is in essence an accounting system for quantifying and displaying habitat availability for aquatic and terrestrial wildlife. HEP is based on habitat suitability index (HSI) models that quantitatively describe the habitat requirements of a species or group of species. HSI models use measurements of appropriate variables to rate the habitat on a scale of zero (0) which is defined as unsuitable to one (1.0) which is optimal. In a typical HEP study, a number of evaluation species or "target species" are chosen for each cover or habitat type (aquatic and terrestrial) identified within the study area. Species may be chosen because of their ecological, recreational or economic value. The evaluation species may also be chosen to represent groups of species; i.e., guilds, which have similar habitat needs (Roberts and O'Neal, 1985).

Once cover types or habitat units have been mapped and the evaluation or "target" species chosen for the study area, habitat variables contained in the HSI models for each species are measured from maps and aerial photographs and supplemented or proofed by on-site sampling. For this HEP Analysis, the most current LIDAR data was also utilized for mapping and habitat unit area calculations. HSI values are then calculated and the initial or baseline number of habitat units (HU) is determined for each species. One (1) HU equates to one (1) acre of optimal habitat for the chosen species. The number of HU's for a species is calculated as the number of acres of available habitat times its suitability for that species (HU = HSI x acres).

The habitat units (HU) available to each species are estimated for each of several target years (TY) over the life of the proposed project (generally 50 to 100 years). Estimates of future habitat conditions are made for the "without project" alternative and for each "with project" alternative. Impacts on each species are then determined by calculating the difference in average annual habitat units (AAHU's) between with and without project alternatives. Development of mitigation plans involving tradeoffs of one sort of habitat for another may involve the use of relative value indices that express the relative priority or importance of the evaluation species or their habitats (Wakeley and O'Neal, 1988).

STUDY AREA AND METHODS

STUDY AREA

Definition of the study area should consider the purposes of the study, significant changes that may occur in existing habitat and the interrelationships of species within the biological community that presently exist or could exist there in the future. The study area should include those areas where biological changes related to the land or water use proposal under study are expected to occur. The study area should include areas that will be affected, either directly or indirectly by the proposed use. As noted, the study area for this HEP analysis is defined as the two (2) project areas for the two (2) structural alternatives under evaluation.

PROJECT ALTERNATIVES

The final array of alternatives carried forward for consideration included the No Action Alterative, Alternative A (non-Structural), Alternative B (Plan 13 as defined by the initial array of alternatives), referred to as the Levee Plan and Alternative C (Plan 15 also under the original array of alternatives) and referred to as the Channel Improvements Plan. Details of each alternative are included in this section. In addition, Appendix A contains the mapping reflecting the extent of the two (2) structural alternatives included in this analysis.

No Action Alternative (Future Without-Project Condition)

Under the No Action Alternative, no flood damage reduction project would occur. The area would continue to experience flooding caused by the headwaters of the Pearl River as well as more localized events. As already presented in the Integrated Draft Feasibility and Environmental Impact Statement documentation, impacts would continue to be substantial and could possibly increase due to ongoing urban development and would continue to impact structures, infrastructure, transportation, and public facilities within the Jackson Metropolitan Area.

Alternative A (Non-Structural)

The measure of relocating structures (buy out) allows for moving structures as part of the project and buying the land upon which the structures were located. The total number of structures to be relocated in this alternative would be in excess of 3,100 including residential, commercial, schools, and hospitals. This

does not include structures behind existing levees although some probability of damage and risk in these areas will still exist. Under this alternative, risk reduction would not be provided to existing structures, including the City of Jackson Wastewater Treatment Plant Site.

Alternative B (Levee Plan)

Under this alternative, new levees would be constructed on both the east and west side of the Pearl River and the expansion of portions of the existing approximately 13.5 miles of levee that are currently in place. In addition, some areas would include newly constructed floodwalls due to right-of-way restrictions. Additionally, significant conveyance improvements would be constructed from RM 292 to RM 302 on the west bank of the river to reduce induced flooding from the new levees and reduce any impacts to the outlet structure of the Ross Barnett Reservoir.

Alternative C (Channel Improvements Plan)

This alternative consists of significant channel modification from RM 284 to RM 293.5. Levees exist within much of this reach and would be relocated in some areas to reduce flood levels. This alternative would consist of excavating the overbanks of the channel. Excavation would be placed adjacent to existing levees or adjacent to relocated levees. The large amount of excavation needed would create substantial land mass or expanded levee widths providing additional protection and additional risk reduction. The weir currently located at RM 290.7 would be removed and a new weir with a gate for low flows would be constructed near RM 284.3. This modification to a higher elevation and expanded width would provide a larger body of water for recreation while reducing channel maintenance. Additional pumps would not be needed to provide protection behind levees except where pumps already exist and would be modified as needed. A small levee segment would be constructed on the west bank approximately from RM 297 to RM 298 to mitigate flood risk in this area.

COVER TYPES

The completion of the HEP analysis requires the delineation of all cover types found within the defined study area. Cover types serve three main functions in a HEP analysis. The cover types facilitate the selection of the evaluation or "target" species. In addition, extrapolation of data from field sampled areas verses non-sampled areas can be done with a higher level of confidence if the study area is divided into relatively homogeneous areas. Additionally, separation of the study area into cover types facilitates treatment of the HEP data

and allows the models to develop more accurate habitat units used in the evaluation of the target species.

Specifically, the study area defined for the proposed Rankin-Hinds County, Mississippi Flood Damage Reduction Study is located within the confines of the Jackson Metropolitan Area. The study area consists largely of bottomland hardwood forests interspersed with oxbow lakes and supporting cypress-tupelo associations. In addition, upland habitats are present on the higher elevations that contain both pine and mixed pine and hardwood timber stands. There are several areas located throughout the study area that have been converted to more early successional scrub-shrub habitat types as a result of timber harvesting activities. In addition, a fairly substantial floodway management area located in the southern portion of the project area is also maintained in a general scrub-shrub habitat type. Though the Jackson Metropolitan Area has become highly urbanized, the preponderance of the study area remains largely undeveloped and remains in a primarily forestland habitat type.

Development of the cover types utilized in this HEP analysis was initially based upon cover type delineations of aerial photography coverage of the study area. Delineations of cover types was completed utilizing the 2012 National Agricultural Imagery Program (NAIP) color photography and the 1996 USGS NAPP color infrared photography covering the study area. The delineation of cover types was completed utilizing ESRI Geographic Information Systems (ArcGIS). Acreage estimates for each cover and/or land use type delineated in the original mapping efforts were also developed utilizing ArcGIS.

The ArcGIS mapping and cover type delineations were supplemented and refined by utilizing the Light Detection and Ranging (LiDAR) data that was available for the study area. The available elevation data in a Digital Earth Model (DEM) grid format was utilized to help facilitate the determination of observed elevation changes associated with the different cover types observed during the field assessments within the study area. LiDAR was utilized to capture the DEM data within ArcGIS to help in the determination of the extent of each cover type for the analysis. The elevation data utilized was obtained from the Mississippi Department of Environmental Quality (MDEQ) and the USGS Hinds County, Mississippi 2006 data collection and the MDEQ and USGS Rankin County, Mississippi 2013 DEM datasets. The data sets for both collection efforts consists of DEMs created from high resolution, airborne collected LiDAR elevation data.

The original cover types and/or land use types were first classified as specific descriptive habitat types that best fit the observed characteristics from the aerial photography coverage. A detailed ground truthing process was employed

wherein specific data points were established within the delineated cover or land use types to clarify the types identified in the photo interpretation and delineation process. Global Positioning System (GPS) points were taken at each sampling point to help justify the ground truthing to the cover or land use type delineations and to provide base data for the HEP analysis. It should be noted that the HEP analysis ground truthing was conducted at the same time that the wetlands field delineation and determination was conducted.

The study area was classified into the following cover types: emergent wetland, lacustrine, mixed forested wetlands, mixed scrub-shrub wetland, palustrine, riverine, upland evergreen forest, upland grassland, upland mixed forest, upland pasture, upland shrub lands and upland urban. The area included within each cover type was estimated utilizing the ArcGIS technology from the aerial photographs and justified through ground truthing and GPS technology as previously discussed herein. The acres and hectares determined to be in each cover type for each alternative, as well as, the percent coverage of each cover type, is shown in the following tables.

Cover types and acreages present for the Levee Plan model for the Rankin-Hinds Flood Damage Reduction Project			
Cover Types	**Levee (acres)**	**Levee (hectares)**	**Percent**
Emergent wetland	5.88	2.38	0.75
Lacustrine	28.24	11.43	3.59
Mixed Forested Wetland	291.49	117.96	37.10
Mixed Scrub-Shrub Wetland	30.12	12.19	3.83
Palustrine	18.54	7.50	2.36
Riverine	9.42	3.81	1.2
Upland Evergreen Forest	16.26	6.58	2.07
Upland Grassland	37.68	15.25	4.8
Upland Mixed Forest	326.88	132.28	41.6
Upland Pasture	-0-	-0-	-0-
Upland Scrub-Shrub	8.89	3.60	1.13
Upland Urban	12.39	5.01	1.58
	785.80	**317.99**	**100**

Cover types and acreages present for the Channel Improvements Plan model for the Rankin-Hinds Flood Damage Reduction Project			
Cover Types	**Channel Improvements (acres)**	**Channel Improvements (hectares)**	**Percent**
Emergent wetland	59.19	23.95	2.07
Lacustrine	200.09	80.97	7.00
Mixed Forested Wetland	911.58	368.90	31.91
Mixed Scrub-Shrub Wetland	256.04	103.62	8.96
Palustrine	147.20	59.57	5.15
Riverine	287.16	116.21	10.05
Upland Evergreen Forest	14.44	5.84	0.51
Upland Grassland	151.79	61.43	5.31
Upland Mixed Forest	536.47	217.10	18.70
Upland Pasture	54.41	22.02	1.9
Upland Scrub-Shrub	208.68	84.45	7.31
Upland Urban	29.60	11.98	1.04
Total	**2,856.62**	**1,156.04**	**100**

EVALUATION SPECIES

The evaluation species form the basis for the HEP analysis. An evaluation species can be a single species, a group of species, species life stage or a species life requisite. The evaluation species are used in HEP to quantify habitat suitability and determine changes in the number of available habitat units (HU's). As a result, the HEP analysis is directly applicable only to the evaluation species selected. The degree to which predicted impacts for these species can be extrapolated to a larger segment of the wildlife community depends on careful species selection.

Sixteen (16) evaluation species were selected for the HEP analysis completed for the Rankin-Hinds County, Mississippi Flood Damage Reduction Plan. Based upon the assessments completed relative to the available habitat and/or cover types, the combined habitat requirements of these species were believed to best reflect the important wildlife values of the various habitats or cover types in the study area. In addition, the specific species selected are also relative to the available HEP models.

Several selected evaluation species are known to inhabit the upland pine, mixed pine-hardwood and bottomland hardwood forestland areas that make up the majority of the project study area. These species include the barred owl (*Strix varia*), the gray squirrel (*Sciurus carolinensis*), the swamp rabbit (*Sylvilagus*

aquaticus), great blue heron (*Ardea Herodias*), the great egret (*Casmerodius albus*) and the wood duck (*Aix sponsa*).

The barred owl typically requires more expansive forestland habitats that contain large mature and decadent trees that provide cavities suitable for security and reproduction. Small mammals are the primary component of the barred owl's diet. From a cover standpoint, the barred owl appears to prefer older more mature stands of timber but they are known to inhabit earlier stage successional areas if there are a sufficient number of large diameter trees or snags present. Although the barred owl may occasionally inhabit small woodlot type areas, they are much more common in larger and more extensive forestland areas. Adequate nesting habitat is often the limiting factor for the successful habitation of a forestland area by the barred owl. The typical barred owl nest tree is tall, decadent, and has a suitable cavity or nest site in the upper portion of the tree bole. Most of the nest sites observed in Mississippi are in cavities in living trees. Based upon available literature, the most critical component of barred owl habitat appears to be availability of trees of sufficient size to provide cavities that are required for nesting.

The gray squirrel also tends to prefer a more mature forestland habitat type with an abundance of mast bearing trees such as oaks and hickories. The gray squirrel typically inhabits both bottomland and upland hardwood and mixed pine and hardwood forestland areas. Although they may occur in a variety of forest types, they prefer larger, densely forested areas typical of more mature timber stands. Large, dominant trees with exposed sunlit crowns are generally the primary seed producers in the type closed canopy timber stands found within a more mature forestland type. Tree cavities found in more mature timber stands are the preferred nesting and wintering shelter for the gray squirrel even though they sometimes utilize leaf nests. A significant amount of preferred gray squirrel habitat is present throughout the proposed project study area.

Swamp rabbits occur primarily in wetland and wetland-associated habitats throughout much of the southeastern United States and, specifically within the wetland forestland habitats found within the project area. Sedges and grasses appear to be the primary food sources for the swamp rabbit. However, in general, the food habits of the rabbits are not highly restrictive. A wide variety of herbaceous vegetation is characteristically consumed during the spring, summer and early fall. Bark, buds and twigs of woody vegetation are consumed during the remainder of the year.

Suitable habitat for the swamp rabbit ranges from bottomland hardwood forestland areas to herbaceous dominated coastal marshes. The swamp rabbit is

rarely found far from water and wetland habitats. It is a very common species found within floodplain bottomland hardwood forests along tributaries of large rivers, streams and swamp areas such as those found within the proposed project study area. Typically, swamp rabbits utilize brushpiles, downfall and dense herbaceous vegetation for cover. Swamp rabbit nests are usually found on the ground and are constructed with stalks of herbaceous vegetation and are lined with fur. Nests are commonly found under brush, plant debris or in other dense vegetative cover. The swamp rabbit requires relatively large tracts of suitable habitat to maintain viable populations.

Suitable habitat for the great blue heron ranges from freshwater lakes and rivers to brackish marshes, lagoons, mangrove area and coastal wetlands. Great blue herons feed anywhere they can locate prey. They can be solitary or flock feeders. Their typical diet consists of fish, small reptiles, amphibians and other crustaceans. Cover for concealments does not appear to be a limiting factor for the great blue heron. They nest in trees or bushes near the water's edge, often on islands or partially isolated spots.

The great egret, a large white heron, is typically associated with streams, ponds, lakes, mud flats, swamps, and freshwater and salt marshes feeding on fishes, amphibians, reptiles, crustaceans and insects. Great egrets are versatile nesters utilizing trees, shrubs and ground sites in riparian forests, swamp and island habitats. Human disturbance and habitat alterations are two significant factors contributing to the decline of the great egret's range.

The wood duck is one of the most stunningly colored birds in North America. They inhabit creeks, rivers, floodplain lakes, swamps and beaver ponds. They are considered primarily herbivorous but will consume invertebrates. The wood duck may utilize cover from trees or shrubs overhanging water, flooded woody vegetation, or a combination of the two cover types. Wood ducks seem to thrive when open water alternates with 50-70% vegetative cover allowing the duck to hide and forage. Nests occur in tree cavities or man-made cavities varying in size since the wood duck cannot create its own cavity.

The brown thrasher (*Toxostoma rufum*) occupies a wide variety of cover types within their breeding range. The highest densities, however, are typically found within dense woody vegetation associated with scrub and shrub type habitats, thickets, hedgerows, forest edges or mid-successional forests like cutover forestland areas. Within the project study area, they are known to occur within the edges of the open field grassland areas but primarily within the scrub-shrub type early successional forestland areas. The brown thrasher is an omnivorous ground forager that occasionally ascends shrubs and trees to feed on berries and fruit. Invertebrates and plant seeds are the principal foods in the breeding range

during the spring with fruit and berries becoming a predominant food source during the summer months. During the winter, they shift to a predominantly invertebrate diet. Brown thrashers typically nest in shrubs and trees but have been known to nest on the ground. The male birds are territorial and both sexes share incubation and care of the young. Though they are a migrant species, their breeding and wintering ranges tend to overlap in Mississippi.

The eastern meadowlark (*Sturnella magna*) prefers open, grassy areas with nearby singing perches. The meadowlark is an omnivorous ground feeder that generally nests in open fields. Approximately 74 percent of the eastern meadowlark's annual diet consists of animal matter and includes mainly beetle, grasshoppers, caterpillars, and occasionally flies wasps and spiders. Cricket and grasshoppers comprise 26 percent of the annual diet and beetles make up 25 percent of the annual diet. The remainder of the diet consists of vegetable matter, mainly grain and weed seeds.

The eastern meadowlark is primarily found in grasslands, meadows and pastures or other open field habitats. The preferred nesting habitat is pasture areas followed by hayfields, soil bank fields, winter wheat fields, idle areas and fallow areas. Nests of the eastern meadowlark are built in shallow depressions and have a dome-shaped roof constructed of grass and frequently interwoven with clumps of grasses or weeds. Elevated singing and lookout perches such as telephone wires, electric power lines, mounds of earth, farm implements or fence posts are used by males. Domestic cats and dogs tend to prey on the eggs and young of the eastern meadowlark. Close proximity of nesting sites to human habitations is also undesirable. In addition, mowing and heavy grazing by livestock may destroy meadowlark nests.

The slider turtle (*Pseudemys scripta*) is a predominantly aquatic turtle that inhabits southern waters. This species occurs in virtually all types of water bodies (e.g., rivers, ditches, sloughs, lakes and ponds). The slider turtle prefers quiet water approximately one (1) to two (2) meters in depth with a soft bottom, abundant vegetation and suitable basking sites. The habitat requirements of the slider turtle are broad. It exists sympatrically with other freshwater turtles within its range. The slider is considered a diurnal turtle. It feeds mainly in the morning and frequently basks on shore, on logs, or while floating during the rest of the day. At night, it sleeps lying on the bottom or resting on the surface near brush piles and hummocks.

Sliders are omnivores. Juvenile sliders are primarily carnivorous whereas adults tend to be herbivorous. Preferred foods include crustaceans, mollusks, adult and larval insects, fish, tadpoles and frogs. Plants in the diet include filamentous algae, duckweed (*Leman spp.*) and a wide variety of emergent and submerged

aquatic plants. In addition, they are frequently observed eating carrion found in the water. Since the sliders have a generalist diet, their ability to migrate both aquatically and terrestrially enables sliders to thrive where resources have a patchy distribution.

Mating occurs in the water but some suitable terrestrial area is required for egg-laying by nesting females. The nesting season in most cases extends from April through July in the southeast and females may nest once or twice during this period. Nests are common in open sites close to water. The nests are usually placed in loose soil that remains above the water table.

Water is an essential requirement in the ecology of this semi-aquatic species. Dense surface vegetation provides cover from predators and supports high densities of aquatic invertebrates and small vertebrates which offer better foraging than open water. As such, the slider turtle is a common associate observed within the oxbow lake areas found throughout the project study area. Sliders tend to move between habitats by both overland and aquatic routes either as a necessity to find food or to escape desiccating aquatic habitats. However, except for nesting females, movement from an aquatic habitat is not necessary for maintaining a population since they have a tendency to remain in their natal habitats for years. Thus, if a habitat provides suitable resources, it can sustain a healthy population of these turtles.

Aquatic habitats (i.e. lakes, rivers and intermittent streams) were assessed utilizing HEP models for the black crappie (*Poximoxis nigromaculatus*), the bluegill (*Lepomis macrochirus*), the common carp (*Cyprinus carpio*), the channel catfish (*Ictalurus punctatus*), the large-mouth bass (*Micropterus salmoides*), the redear sunfish (*Lepomis microlophus*), and the white crappie (*Poximoxis annularis*).

The black crappie is large sunfish that can grow as large as 16 inches and weigh as much as 5 lbs. They typically live in warm ponds, lakes, streams and reservoirs and prefer to be in groups. They are abundant in low gradient streams with low turbidity and low velocity. They prefer lots of plants and underwater structure, such as logs, stumps and rocks. The black crappie is an opportunistic feeder eating small fish, insects and crayfish. They are also known to eat just about anything that will fit in their mouth.

The blue gill is a freshwater species of sunfish that lives in shallow waters of lakes and ponds along with the slow-moving areas of streams and small rivers. They prefer cover to hide such as aquatic plants and fallen logs. They are opportunistic feeders with a diet consisting of insect larvae and small fish and will eat vegetation if food is scarce.

The common carp is an opportunistic feeder able to utilize any available food source. The carp prefers enriched, shallow warm, sluggish, and well-vegetated waters with a mud or silt substrate. They are extremely tolerant of turbidity as long as food is not limited.

The channel catfish populates a broad range of environmental conditions. Optimum riverine habitat is characterized by warm temperatures and a diversity of velocities, depths and structural features for cover and food. Optimal lake habitat for proliferation includes a large surface area, warm temperature, high productivity with abundant cover and low to moderate turbidity.

The largemouth bass prefers a lacustrine environment with extensive shallow areas that support some level of aquatic vegetation. Optimal riverine habitat includes large slow moving rivers or pools of streams with soft bottoms, aquatic vegetation and relatively clear waters. Their diet typically consists of aquatic insects, crayfish and smaller fish. The bass prefers areas low in salinity, with dissolved oxygen levels above 8 mg/liter and are intolerant of suspended solids.

The redear sunfish, commonly referred to as the shellcracker, prefers lacustrine environments over riverine. They primarily feed on the bottom and seldom feed on the surface. They prefer warm large lakes, bayous, marshes and reservoirs with vegetated shallow areas and clear waters. In riverine systems, they prefer large, clear, low gradient streams and rivers with sluggish currents and some aquatic vegetation. Their diet consists of larvae, mayfly and dragonfly naiads and, they will also consume small clams and freshwater pawns.

The white crappie is abundant in reservoirs and lakes greater than 5 acres in size. They also can occupy pools and overflow areas of larger rivers. They typically congregate in loose aggregations around submerged trees, stumps, brush, aquatic vegetation and boulders. Food consists of algae and zooplankton for the young, while the juveniles prefer planktonic insects, large adults feed primarily on small fish.

HABITAT SUITABILITY INDEX MODELS

Published Habitat Suitability Index (HSI) models were available for the sixteen (16) evaluation species. These include published HSI models for the barred owl (Allen 1987a), gray squirrel (Allen, 1987b), swamp rabbit (Allen, 1985), brown thrasher (Cade, 1986), eastern meadowlark (Schroeder and Sousa, 1982) and slider turtle (Morreale and Gibbons, 1986), black crappie (Edwards, et. al, 1982), the bluegill (Stuber, Gebhart and Maughan, 1982), the channel catfish (U.S. Fish and Wildlife Service, 1981), the common carp (Edwards and Twomey, 1982), the great blue heron (Short and Cooper, 1985), the great egret (Chapman and

Howard, 1984), the largemouth bass (Stuber, Gebhart, and Maughan, 1982), the redear sunfish (Twomey et. al, 1984), the white crappie (Edwards et. al , 1982) and the wood duck (Sousa and Farmer, 1983).

SAMPLING SCHEME

Habitat variables contained in the HSI models were measured during the time period of April 2013 through June 2014. As previously noted, the sampling was conducted as an integral part of the wetlands field delineation and determination that was also conducted for the project areas for both Alternative B and Alternative C, the two (2) structural alternatives evaluated. The sampling scheme was designed to include all habitat types of concern within the designated Rankin-Hinds County, Mississippi Flood Damage Reduction Study area. The sampling scheme was also designed to provide field information that was used to justify the acreages determined to be present within each habitat type.

Habitat variables were measured within 0.10 acre (37.5 foot radius) circular plots randomly placed throughout a sampling of the different habitat or cover types. Sample points were randomly selected based upon GPS coordinates from the habitat type locations from the 1996 NASA NAPP color infrared photography and the 2012 USGS NAIP color aerial photography used in the cover type delineation process. The sample points are also associated with the data points collected during the aforementioned wetlands field delineation and determination.

PLOT SAMPLING

Habitat variables for the terrestrial evaluations were either estimated directly or calculated later from data collected in the field. All data were collected on a 0.10 acre plot (37.5 foot radius). The HEP analysis completed for the Levee Plan was completed for primarily linear projects and therefore utilized transects run along the proposed levee alignment centerlines and within the proposed floodway clearing areas. The Channel Improvements Plan project area includes a much more extensive construction area and that limits itself to the use of a point sampling scheme which was based upon sampling within cover types. Once again, the field sampling for the HEP analysis was taken in conjunction with and utilizing the same primary data points that were included in the wetlands field delineation and determination assessments.

Plots were first classified by cover type and then the tree layer was sampled. The tree layer consisted of all woody plants greater than 20 feet tall. Trees within the plot were classified visually as either overstory or understory trees and identified

by species. The DBH of each tree in the plot was measured to the nearest inch and the average height of all trees (VHTTR01) was estimated visually and checked occasionally with a clinometer. Tree counts and DBH measurements were later used to calculate the mean DBH of the overstory trees (VDBTR01), density of trees greater than 20 inches DBH (VDNTR04) and the number of hard mast species with canopy cover greater than one (1) percent (VSDHM01).

Visual estimates of percent cover were made at each plot location within the different cover types. In the forested areas, percent cover was estimated separately for all trees within the plot (VCVTR01) and for the hard mast species (VRCHM01) that were present. In the cypress-tupelo swamp cover types (CYP), cover of emergent herbaceous vegetation (VCVEM03) was estimated. In the grassland (GRS) and shrubland (SHR) cover types, herbaceous ground cover (VCVHE01), grass cover (VRCGR01), shrub cover (VCVLT03) including woody plants three (3) to twenty (20) feet tall, and percent of ground area with leaf litter greater than 0.5 inch deep (VCVLT03) were estimated. Density of woody stems greater than three (3) feet tall (VDNSH02) was determined by either counting all stems within the plot or by sub-sampling a portion of the plot and extrapolation.

The variable CAV+SNG was estimated by adding the number of trees, living or dead, with one or more cavities greater than one (1) inch in diameter, as well as with the number of snags greater than four (4) inches in diameter. The cavities must be present in the trunk or limbs greater than four (4) inches in diameter. Additionally, the snags must be greater than six (6) feet tall.

The slider turtle HSI model requires an estimate of mean water depth (WDP01), mean current velocity (WVE01), water temperature (X125V5) and inundation regime (WRE01). WDP01 was estimated by estimating depths at various points within the sample plots. Water temperatures were measured using a thermometer submersed for at least one (1) minute. WVE01 was estimated to be zero since all sample sites were natural impoundments with permanent water. WRE01 was required only for the slider turtle model. Since bottomland hardwood sites were either temporarily or intermittently flooded, the value was near optimal for swamp rabbits.

Some of the key variables used for HSI models for the aquatic species include the percent of vegetative cover, average water depth, average total dissolved solids, stream gradient, maximum salinity, the minimum dissolved oxygen, pH levels, substrate for food composition and average water level fluctuations.

In addition, The U.S. Army Engineer Research and Development Center (ERDC), Environmental Laboratory completed the Pearl River Watershed Feasibility Study, Two Lakes Flood Control Plan Aquatic Evaluation in April 2006. The 2006 Aquatic Evaluation was for a significantly larger project area but it is also

inclusive of the current project area. As a result, the 2006 Aquatic Evaluation was utilized as a part of the current HEP analysis update for the existing project alternatives. As such, the habitat variables utilized in the 2006 Aquatic Evaluation were also utilized as a part of this HEP analysis process. A copy of the 2006 Aquatic Evaluation is included as Appendix C to this report.

All habitat variables utilized in the HEP analysis were defined by the HSI models for each evaluation species and in conformity to the habitat variables utilized in the previously conducted HEP analysis for the prior project alternatives. Some of the key HEP variable definitions utilized in the HEP analysis for the proposed Rankin-Hinds County, Mississippi Flood Damage Reduction Study area are listed in Appendix B.

ANALYSIS OF IMPACTS

HSI DETERMINATIONS AND HEP SOFTWARE

HSI models were programmed into a standard spreadsheet program and habitat data for each sample plot in each cover type were entered into models for each of the appropriate evaluation species. An HSI value for each species on each plot was determined. HSI values for each species were averaged across all plots of similar cover type. Average HSI values and cover type quantities were used as input to the HEP analysis for the project study area and to calculate the habitat units (HU's) for each species and for each cover type found within the study area.

As a part of the HEP analysis completed for this evaluation, the HSI values developed for the evaluation species for the previous study efforts were further evaluated for applicability to the existing cover types found within the current study area. Based upon the comparisons completed relative to the previously developed HSI values and the current cover types found within the study area, it was determined that the HSI values for each of the evaluation species and for each of the study efforts are relatively the same. In addition, HSI values were developed for each of the evaluation species used for the current study effort that were not utilized during the previous study efforts and for which models are now relatively available.

In addition to the HSI values assessment and comparisons, the cover types utilized for the previous study efforts were also analyzed relative to the current cover types found within the study area. It was also determined that the cover types found within the study area have also remained fairly constant relative to the previous study efforts with the major differences being in the area of coverage for specific cover types. Therefore, a consensus was reached that the HSI values for the evaluation species previously utilized in the previous study efforts would remain constant as well as the cover types utilized where possible.

As discussed, the HEP analysis completed for the Rankin-Hinds County, Mississippi Flood Damage Reduction study is intended to provide an assessment of the habitat losses associated with the construction of the two (2) structural alternatives, the Levee Plan (Alternative B) and the Channel Improvements Plan (Alternative C). The decision to utilize the same HSI values for both plans is predicated upon the ability to make comparisons between the two plans and to provide for continuity for evaluation of the flood control alternatives in general. The following table includes the HSI values for each evaluation and cover type assessed.

The Mean Habitat Suitability Index (HSI) Values for Evaluation Species

Species	Emergent	Lake	Mixed Forested Wetlands	Scrub-Shrub wetland	Palustrine	Riverine	Upland Mixed Forest	Upland grassland	Upland pasture	Upland scrub-shrub
Barred owl			0.57		0.55		0.59			
Black crappie		0.88				0.72				
Bluegill		0.79				0.8				
Brown thrasher								0.29	0.29	0.29
Channel catfish		0.61			0.78	0.78				
Common carp		0.75				0.8				
Eastern Meadowlark								0.62	0.62	
Gray squirrel			0.49				0.61			
Great blue heron	0.87		0.75	0.75	0.75	0.75				
Great Egret				0.3	0.3					
Largemouth bass		0.95				0.95				
Redear sunfish		0.78				0.78				
Slider turtle	0.6	0.6		0.2	0.2	0.33				
Swamp rabbit			0.8	0.52	0.52					
White crappie		0.82				0.91				
Wood duck	0.22		0.91	0.75	0.75	0.91				

PROJECT LIFE AND PERIOD OF ANALYSIS

HEP requires that habitat availability for each species be estimated, for each of several target years, over a period of analysis that may include the life of the project plus any additional pre-project impact period. For the Rankin-Hinds County, Mississippi Flood Damage Reduction study, the 100-year economic life of the project begins 2021 and ends in 2121.

Work is estimated to begin in 2021 and there would be continuous impacts occurring during the three (3) year construction period until 2024. It was assumed that one-fifth of all impacts would occur by TY-1 and that all impacts would have occurred by TY-3. An additional target year at year 30 (TY-30) was

used to account for management practices and timber stand diversity and changes during the project life. This approach tends to overestimate average annual impacts but not to a degree that is unrealistic.

CALCULATING AVERAGE ANNUAL HABITAT UNITS

Average annual habitat units (AAHU's) were determined by annualizing the total habitat units (HU's) available over the 100-year economic life of the project and the three (3) year construction period. Impacts of both the Levee Plan and the Channel Improvements Plan were determined by calculating the net change in AAHU's between the with-project and without project alternatives for each evaluation species. The HEP guidance requires that all identified cover types available to a species be combined and a weighted HSI on the basis of acreage be used in the HEP analysis.

ASSUMPTIONS

During the previous studies, several cutover forestland areas were identified and cataloged as shrubland cover types. Since that time, much of this area has been allowed to grow back naturally and the character of these timber stands has changed in the period since that study was completed. Conversely, other forested areas have been clearcut during the same period. One assumption included in this HEP analysis was that the landowners would allow natural succession to occur through time and that timber harvesting activities would not be as extreme as what had previously taken place. It appears, based upon field observations, that is the case and portions of these areas were included in either the bottomland hardwood (BLH) cover type or in the mixed pine and hardwood (MPH) cover type for the purposes of the HEP analysis for the Rankin-Hinds County, Mississippi Flood Damage Reduction study area. As was the case in the previous studies that were conducted, it was assumed that future harvest activities within the study area would be accomplished on a much smaller scale through the implementation of small area clearcuts and/or selective harvest which would not result in appreciable changes in the overall structure of the study area forests. It is also assumed that the timber harvest activities employed within these much smaller harvest areas would likely be offset by successional changes in other undisturbed portions of the study area.

The nature of the type construction that would be utilized for either of the two (2) structural alternatives included in the proposed Rankin-Hinds County, Mississippi Flood Damage Reduction study is such that a significant change in the existing habitat types will take place within the study area. As previously noted, the study area for the Rankin-Hinds County, Mississippi Flood Damage Reduction study HEP analysis was defined as the overall footprint of the

proposed channel improvements excavation area, the proposed dredge disposal areas, the proposed new levee segments and the associated floodway clearing areas.

In the case of the Channel Improvements Plan alternative, much of the existing forestland and other identified cover types will be converted to an open water habitat that would continue to exhibit riverine functions, specifically those areas within the channel excavation area. The portion of the study area included within the proposed dredge disposal areas would be filled and converted from what is now primarily forestland habitat types to what would most likely become either upland grassland or a scrub-shrub habitat, particularly in the short term of the project life. There is also the possibility that the proposed dredge disposal areas would become urban development areas over time.

In the case of the proposed new levee segments, it can be assumed that the new alignments would be maintained in a grassland cover type once construction is completed. Additionally, it can be assumed that the proposed floodway clearing limits would be maintained as a scrub-shrub habitat type through time with ongoing maintenance activities.

It is obvious, based upon the proposed project design features for both structural alternatives, significant habitat changes will occur as a result of either of the alternatives and therefore the habitat suitability for each of the evaluated species will change. For all of the evaluation species but the slider turtle, HSI values will diminish through the life of the project and, for the most part, will be significantly less immediately following the completion of the construction period.

Based upon the habitat factors evaluated, assumptions for HSI values were developed for each evaluation species based upon the critical habitat factors included in each HSI Model for the individual species. The assumed HSI values were developed based upon the habitat conversions that would take place for each evaluation species based upon the proposed project design criteria.

For the with-project conditions for the proposed channel improvement excavation areas, it was assumed that all of the acreage contained within the proposed channel improvement excavation areas would convert from the predominant riparian forestland habitat that now exists to an open water habitat. It was also assumed that the proposed dredge disposal areas along the banks of the channel excavation areas would eventually become some type of urban development area. Therefore a transition in acreage is shown to reflect anticipated development post project construction.

However, it should be noted that a certain percentage of the existing forestland habitat within the channel excavation areas will remain in the existing forestland habitat and will create "island features" within the excavated channel areas. In addition, it is assumed that these areas would be maintained in the existing forestland habitat through the life of the project.

It was assumed that the acreage associated with the proposed levee alternative project, specifically the levee segment alignments, would become grassland while the floodway clearing limits would become and would be maintained as scrub-shrub habitat throughout the life of the project.

RANKIN-HINDS COUNTY, MISSISSIPPI FLOOD DAMAGE REDUCTION STUDY AREA
ACRES OF COVER TYPES WITHIN PROJECT IMPACT AREAS

Cover Type	**Acres/Impact Area**		**Total**
	Channel Improvements	Levee	
Emergent	59.19	5.88	65.07
Lacustrine	200.09	28.24	228.33
Mixed forested wetlands	911.58	291.49	1,203.07
Mixed scrub wetlands	256.04	30.12	286.15
Palustrine	147.20	18.54	165.73
Riverine	287.16	9.42	296.58
Upland evergreen forest	14.44	16.26	30.70
Upland grassland	151.79	37.68	189.47
Upland mixed forest	536.47	326.88	863.34
Upland pasture	54.41	0	54.41
Upland shrub-land	208.68	8.89	217.57
Upland urban	29.60	12.39	41.99
Total	**2,856.62**	**785.80**	**3,642.42**

The Average Annual Habitat Units (AAHU's) were developed for each of the evaluation species based upon the analysis of the proposed Rankin-Hinds County, Mississippi Flood Damage Reduction Plan structural alternatives. The AAHU's for each evaluation species are based upon the Habitat Suitability Index (HIS) values that were developed as a part of the habitat assessment and the anticipated changes that would take place within the study area/project area through time for both the alternatives "with project conditions" and the "without project conditions". The following table depicts the Average Annual Habitat Units (AAHU's) for each evaluation species

AVERAGE ANNUAL HABITAT UNITS (AAHU'S)
CHANNEL IMPROVEMENTS ALTERNATIVE

Evaluation Species	No Actions	Channel Improvements
Barred owl	2655.0	-
Black crappie	1,642.18	421.13
Bluegill	376.54	1,460.37
Brown thrasher	98.0	164.29
Channel catfish	295.51	1,487.1
Common carp	1,578.36	345.64
Eastern meadowlark	78.0	363.79
Gray squirrel	2733.0	-
Great blue heron	570.23	1,478.64
Great egret	182.53	-
Largemouth bass	449.41	1,715.97
Redear sunfish	373.9	1,454.74
Slider turtle	308.25	949.31
Swamp rabbit	3379.0	-
White crappie	412.98	1,661.19
Wood duck	1,251.34	1,661.19

The following table includes the net changes in AAHU's for each evaluation species for the proposed Channel Improvements Alternative.

CHANGE IN AVERAGE ANNUAL HABITAT UNITS
FOR THE CHANNEL IMPROVEMENTS ALTERNATIVE

Evaluation Species	**Channel Improvements**
Barred owl	-2655.0
Black crappie	-1,221.05
Bluegill	1,083.83
Brown thrasher	66.29
Channel catfish	1,191.59
Common carp	-1,232.72
Eastern meadowlark	-285.79
Gray squirrel	-2733
Great blue heron	908.41
Great egret	-182.53
Largemouth bass	1,266.56
Redear sunfish	1,080.84

Slider turtle	641.06
Swamp rabbit	-3379
White crappie	1,248.21
Wood duck	409.86

As shown, the barred owl, gray squirrel and swamp rabbit all will lose a significant number of AAHU's over the life of the project. This is due primarily to the amount of existing forestland habitat found within the study area (~65.2%) and the substantial amount of preferred cover types utilized by these species. Those cover types include the mixed forested wetlands, mixed scrub shrub wetlands, palustrine, upland evergreen forestland and the upland mixed forestland cover types preferred by these evaluation species. The significant losses in AAHU's for each of these evaluation species is also due, in part, to the nature of the proposed project construction activities. At present, the project area contains a primarily riparian forestland habitat which contains cover types prevalent to these evaluation species. The creation of the primary aquatic habitat associated with the Channel Improvements Plan will result in the removal of the preponderance of the available habitat that now exists for most all the terrestrial evaluation species.

The conversion of the forested components and riverine habitat within the existing river channel transition into a lacustrine system with flow will significantly reduce the amount of AAHU's for the black crappie and common carp. There are also habitat changes that would occur relative to the available cover types for the great egret that would also result in a reduction in the AAHU's for this evaluation species but not to the same degree as would affect other species evaluated. However, the evaluation completed also recognized that vast amount of aquatic habitat that would be created with the Channel Improvements Plan. Though there is a significant reduction in the available AAHU's for these aquatic evaluation species, the overall gain in aquatic habitat would offset much of the losses for these species.

The change in AAHU's for the eastern meadowlark and brown thrasher are much less severe for the proposed project area. The cover types utilized by these evaluation species will be more prevalent as edge habitat along the expanded channel areas, as cover habitat along the new levee segments and as early successional habitat associated with the project construction activities. The preferred cover types for these species would also be present at differing intervals and specifically following construction with the proposed dredge disposal areas along the channel improvements excavation area. It is also anticipated that these cover types would be present at intervals throughout the project life as a result of normal land management activities.

Conversely, the wood duck, white crappie, slider turtle, redear sunfish, largemouth bass, great blue heron, channel catfish and the bluegill actually reflects a gain in AAHU's. This is due primarily to the construction of the proposed channel improvements areas and the substantial increase in available aquatic habitat for the species versus what would be available with the existing habitat types and what habitat availability would be anticipated through time for the without project conditions.

The following table includes the net changes in AAHU's for each evaluation species for the proposed Rankin-Hinds County, Mississippi Flood Damage Reduction Project Levee Plan Alternative.

AVERAGE ANNUAL HABITAT UNITS (AAHU'S)
LEVEE PLAN ALTERNATIVE

Evaluation Species	No Actions	Levee
Barred Owl	450.0	-
Black Crappie	30.91	-
Bluegill	28.97	-
Brown thrasher	19.0	95.88
Channel catfish	38.89	-
Common carp	28.15	-
Eastern meadowlark	24.95	232.09
Gray squirrel	447.31	-
Great blue heron	926.89	277.52
Great egret	28.47	276.65
Largemouth bass	34.74	-
Redear sunfish	28.6	-
Slider turtle	40.58	178.42
Swamp rabbit	274.85	197.95
White crappie	30.82	-
Wood duck	307.81	240.29

The following table illustrates the net changes in AAHU's for each evaluation species for the Levee Plan impact area.

CHANGE IN AVERAGE ANNUAL HABITAT UNITS (AAHU's)
FOR THE LEVEE PLAN ALTERNATIVE

Evaluation Species	Constructed Levee
Barred Owl	-450.0
Black Crappie	-30.91
Bluegill	-28.97
Brown thrasher	76.88
Channel catfish	-38.89
Common carp	-28.15
Eastern meadowlark	207.14
Gray squirrel	-447.31
Great blue heron	-649.37
Great egret	248.18
Largemouth bass	-34.74
Redear sunfish	-28.6
Slider turtle	137.84
Swamp rabbit	-352.05
White crappie	-30.82
Wood duck	-67.52

All but 4 of the 16 evaluation species exhibit losses in AAHU's over the life of the project. Once again, this is due, in part, by the type habitat that would be impacted and the relationships these evaluation species have with the preferred cover types. In addition, AAHU's are lost for these evaluation species due to the nature of the plan design features including the construction of new levee segments and the floodway clearing along the river channel.

It is anticipated that the brown thrasher, eastern meadowlark, great egret and slider turtle would actually gain AAHU's through the life of the project primarily related with the creation of additional habitat. The proposed levee segments would be grassed following construction and would provide a much more extensive amount of grassland cover type than what currently exists. In addition, areas proposed for clearing for floodways would be maintained as scrub-shrub habitat through time.

COMPENSATION ANALYSIS

The compensation study identifies available measures that would compensate for and offset unavoidable habitat unit (HU) losses related to the proposed action or actions. The compensation is achieved through the implementation of specific management measures to existing habitat that would result in the net increase in HU's. The existing habitat chosen for the implementation of the management criteria may or may not be in the project study area. However, compensation rates related to specific management schemes are typically higher for selected habitats within the project study area or, minimally, within the same drainage basin. To obtain compensation, the HU losses associated with the proposed action must be fully offset by the specified acquisition and/or management measures. The HEP procedures provide for compensation options that include management plans based upon existing conditions in a candidate compensation area or on hypothetical management areas.

The compensation analysis completed for the 2006 Pearl River Watershed Flood Control project study included three (3) different compensation scenarios developed to provide compensation for the project impacts, as did the previous study efforts within the project area. It was assumed that the compensation analysis completed for the proposed Rankin-Hinds County, Mississippi Flood Damage Reduction Study Plan would likewise evaluate similar compensation scenarios.

MANAGEMENT PLAN ALTERNATIVES

The compensation analysis was completed to identify measures that would offset unavoidable HU losses to evaluation species as a result of the two (2) proposed project alternatives. As mentioned earlier, the compensation analysis for the proposed Rankin-Hinds County, Mississippi Flood Damage Reduction Study Plan would likewise evaluate similar compensation scenarios that were utilized in previous studies. These scenarios included an evaluation of three (3) different management plan scenarios that represent the most likely compensation alternatives for the proposed actions. The selected management plan scenarios are also specific to the evaluation of the losses for the terrestrial evaluation species and do not include specific criteria that would address the aquatic habitat losses.

Each management plan scenario included specific management plan criteria to arrive at the desired goal of compensation for the target species. The management plan scenarios selected for the analysis included the acquisition of existing forest land which can be somewhat related to preservation of existing habitats and including a long-term management plan. This management plan

scenario was identified as the **Acquisition Alternative**. The management plan scenarios evaluated also included the restoration of all the existing habitats within the project area and is defined as the **Restoration Alternative**. Under this management plan scenario it is assumed that every existing habitat type found within the project area would be restored at some other location within the Pearl River Basin. The third management plan scenario utilized includes the regeneration of the dominant habitat type within the proposed project areas, the bottomland hardwood forestland habitat type and is referred to as the **Regeneration Alternative**. Under this management plan scenario it is assumed that the off-site restoration activities would focus primarily upon the replacement of the predominant bottomland hardwood forestland cover type and would not focus on the specific replacement of all the existing cover types found within the project areas.

The compensation analysis included the development of basic assumptions that would be included in each management plan alternative evaluated and was based upon the premise that the proposed alternatives would take place within the Pearl River Basin and within the same general geophysical area. Since the channel improvement alternative would impact the largest acreage, the HEP compensation analysis was completed using acreage as large as those anticipated impacts. To that end, an approximately 3,000 acre parcel located to the south of the proposed project area and owned by the City of Jackson was used as a baseline for this analysis. In essence, the City of Jackson property was selected to serve as a "target forest" relative to the implementation of the three (3) possible management plan scenarios that were utilized for the analysis.

A HEP analysis was completed on the approximately 3,000 acre parcel to determine its potential as suitable habitat for the seventeen (17) evaluation species that were utilized. As a result, the HEP analysis developed for the City of Jackson property served as the baseline data for all three (3) proposed management plan scenarios evaluated relative to the proposed project alternatives. In addition, once again, the compensation analysis was completed for terrestrial habitat only. Although a baseline HEP analysis was calculated for aquatic species as well, the management scenarios only yielded estimated improvements in terrestrial habitat. Aquatic species would ultimately benefit from project implementation with the Channel Improvements Plan and the associated increase in aquatic habitats within the project area.

Each management plan scenario utilized has specific habitat goals that increased the potential of the site to create suitable habitat or cover types for the various target species. It should be noted, that the target species utilized were driven by the types of habitat that would occur as a result of the proposed project alternatives. It should also be noted that each management plan scenario and the

related habitat goals are evaluated relative to the potential management functions that can be implemented for each management plan alternative.

In performing a HEP compensation analysis three (3) different compensation scenarios are possible: 1) In-kind (no trade-off) with the compensation goal to precisely offset the HU for each of the evaluation species; 2) Equal replacement (equal trade-off) with the compensation goal to precisely offset the HU losses through the gain of an equal number of HU's and 3) Relative replacement (relative trade-off) with the goal to gain one HU for a target species in order to offset the loss of one HU relative to the proposed project alternatives impacts. Therefore, proposed compensation acreages will vary as a result of the HU's required for the target species. The tables that follow in the discussions below indicate the required number of HU's for each evaluated species while the overall proposed final acreage associated with each management scenario was derived from calculating the "optimum habit" for the target species predicated proportionately upon anticipated "new habitat" that would be developed in the proposed project area.

The first proposed management plan alternative included an analysis of the habitat units provided through the long-term management of existing forestland within the general locale of the project area. This scenario included the assumption that existing forestland would be purchased and a management plan developed that would result in an increase in habitat for the identified evaluation species through the life of the proposed projects. For this reason, it is referred to as the **Acquisition Alternative**. It was assumed for the purpose of this analysis that the cover types within the proposed management plan area occur in the same proportions as those found within the proposed project area. More specifically and as noted previously, an approximately 3,000.0 acre parcel located to the south of the proposed project area owned by the City of Jackson was used as a baseline for this analysis. Additional properties with similar habitat types within the same general locale were also evaluated. It was further assumed that the primarily forested bottomland hardwood habitat found on this property and on similar forestland within the general area could be managed through time to provide an overall increase in habitat units for the evaluation species. Utilizing these properties as a baseline, a Management Plan was developed to use as the assumed forest management baseline for the development of the estimated compensation areas for the impacts associated with each of the two (2) alternatives.

Further assumptions were also made that the Habitat Suitability Index (HIS) values for this proposed management plan scenario are similar in nature to those found within the study area for the without project conditions. Based upon these assumptions, it was estimated that a total of approximately 17,190.0 acres of existing forestland would need to be purchased and a forest management plan developed to increase the habitat suitability through time for the targeted species for the Channel Improvements Alternative.

Based upon this analysis, the purchase and management of the approximately 17,190 acres of existing forestland would slightly over compensate for impacts to habitat suitable for the barred owl, wood duck and swamp rabbit. In addition, the Channel Improvement Alternative would create and/or maintain existing habitat for nine (9) of the seventeen (16) evaluation species. This alternative would, however, significantly under compensate for habitat losses associated with the gray squirrel. This acreage would also over-compensate for the barred owl and swamp rabbit. An increase in habitat units for the brown thrasher, eastern meadowlark, great egret and the slider turtle is anticipated as a result of project completion.

Habitat losses associated with the Levee Alternative were also evaluated and in relationship to losses associated with the Channel Improvement Alternative. Under the compensation analysis completed, a total of approximately 2,250 acres of existing forestland would need to be acquired and placed under a forest management plan to offset losses associated with the Levee Alternative. This proposed acreage would fully compensate for habitat losses for barred owl, swamp rabbit and wood duck and would nearly compensate for losses associated with the great blue heron. This acreage undercompensates for habitat loss associated with the gray squirrel. An increase in AAHU's would be seen for the brown thrasher, eastern meadowlark, great egret and the slider turtle. The following table depicts the actual habitat units gained and the acreage needed to compensate for the habitat losses associated with each of the two (2) proposed alternatives.

HABITAT UNITS AND COMPENSATION AREA DETERMINATION FOR THE ACQUISITION COMPENSATION ALTERNATIVE

Evaluation Species	Constructed Levee	Channel Improvements	Management plan	Compensation Area (Acres)	
				Channel	Levee
Barred Owl	-450.0	-844.72	663.0	12,013.57	2,036.20
Brown thrasher	76.88	35.45	-	-	-
Eastern meadowlark	207.14	231.44	-	-	-
Gray squirrel	-447.31	-753.91	262.0	31,293.89	5,121.87
Great blue heron	-649.37	908.41	665.0	-	2,929.49
Great egret	248.18	-182.53	250.0	-	-
Slider turtle	137.84	641.06	-	-	-
Swamp rabbit	-352.05	-782.12	962.0	10,537.42	1,097.87
Wood duck	-67.52	409.86	629.0	-	322.03

The second management plan scenario for the terrestrial habitats evaluated is referred to as the **Restoration Alternative**. This management plan alternative would include the restoration of existing agricultural land through the conversion to forestland that would include a cover type composition that would be proportionately similar to the cover type makeup found within the study area. This alternative could include the completion of the restoration activities through fee purchase of the property or could be accomplished through the use of perpetual conservation easements with the property remaining in private ownership. It was assumed that the Habitat Suitability Index (HIS) for the evaluation species for the without project conditions could be provided through the life of the project with the restoration activities and associated long-term forest management plan in place. It was also assumed that the restoration efforts could provide a significant increase in habitat suitability for most of the evaluation species throughout the life of the project. Based upon the assumptions used, it is estimated that a total of approximately 9,076.0 acres of restoration of existing agricultural lands to similar cover type proportions would be needed to offset habitat losses associated with the proposed Channel Improvements Alternative. Under this scenario, habitat losses for all terrestrial species would be fully compensated.

The analysis of the habitat losses associated with the implementation of the Levee Plan revealed that a total of approximately 1,836.0 acres of existing agricultural lands would need to be restored to offset impacts to the evaluation species. More specifically, this alternative would fully compensate for the habitat losses of all affected species. The following table depicts the actual habitat units gained and the acreage needed to compensate for the habitat losses associated with each of the two (2) proposed plans.

HABITAT UNITS AND COMPENSATION AREA DETERMINATIONS FOR THE RESTORATION COMPENSATION ALTERNATIVE

Evaluation Species	Constructed Levee	Channel Improvements	Management plan	Restoration Area (Acres)	
				Channel	Levee
Barred Owl	-450.0	-2655.0	2,535.0	1,755.41	532.54
Brown thrasher	76.88	66.29	-	-	-
Eastern meadowlark	207.14	285.79	-	-	-
Gray squirrel	-447.31	-2733.0	1,993.0	1,992.77	673.32
Great blue heron	-649.37	908.41	-	-	1,281.65
Great egret	248.18	-182.53	300.0	3,205.23	-
Slider turtle	137.84	641.06	-	-	-

Swamp rabbit	-352.05	-3379	1,697.0	2,427.95	622.36
Wood duck	-67.52	409.86	2,535.0	1,755.42	129.85

The third scenario evaluated for compensation for each of the two (2) proposed plans is referred to as the **Regeneration Alternative**. This alternative includes the reforestation or restoration of existing agricultural lands through the conversion to a bottomland hardwood forestland habitat type only. Under this scenario, there would be no attempt to develop cover types proportionate to the study area. The restoration would be specific to existing agricultural lands suitable for conversion to a predominantly bottomland hardwood forestland habitat type. As was the case with the proposed restoration scenario, the land utilized for restoration or regeneration to a predominantly bottomland hardwood habitat could either be purchased or placed under a perpetual conservation easement and maintained in private ownership. It was also assumed that the reforestation of a primarily bottomland hardwood forestland habitat type would provide near optimal habitat conditions for most of the evaluation species through the life of the project with the implementation of a balanced long-term forest management plan. It was also assumed that the reforestation to a predominantly bottomland hardwood habitat type would provide optimal opportunity for mitigation for the forested wetland habitat losses associated with both the proposed project plans.

Based upon the evaluation completed, it is estimated that a total of approximately 5,850.0 acres of reforestation of existing agricultural lands to a predominantly bottomland hardwood habitat type would be needed to adequately compensate for the habitat losses associated with the proposed Channel Improvements Alternative. An estimated total of 1,950.0 acres of existing agricultural lands would need to be reforested to predominately bottomland hardwood habitat to compensate for the habitat losses associated with the proposed Levee Alternative. This acreage however would provide adequate compensation for all terrestrial species.

The following table depicts the actual habitat units gained and the acreage needed to compensate for the habitat losses associated for each of the two (2) proposed plans.

HABITAT UNITS AND COMPENSATION AREA DETERMINATION FOR THE REGENERATION COMPENSATION ALTERNATIVE

Evaluation Species	Constructed Levee	Channel Improvements	Management plan	Regeneration Area (Acres)	
				Channel	Levee
Barred Owl	-450.0	-2655.0	3,162.0	1,125.76	426.94
Brown thrasher	76.88	66.29	-	-	-
Eastern meadowlark	207.14	285.79	-	-	-
Gray squirrel	-447.31	-2733.0	2,543.0	1,249.0	527.70
Great blue heron	-649.37	908.41	2,125.0		916.76
Great egret	248.18	-182.53	-	1,619.33	-
Slider turtle	137.84	641.06	-	-	-
Swamp rabbit	-352.05	-3379	3,352.0	983.25	315.08
Wood duck	-67.52	409.86	2,535.0	885.72	103.88

Based upon the evaluations completed, the acreages proposed for each of the management plan scenarios can be adjusted to fully compensate for the habitat losses that would be incurred for each of the evaluation species and associated with each of the two (2) plans. The following table includes the acreages determined through the HEP compensation analysis to provide compensation for the habitat losses associated with each plan.

COMPENSATION ACRES REQUIRED TO OFFSET LOSSES OF TERRESTRIAL HABITAT DUE TO THE CONSTRUCTION OF BOTH ALTERNATIVES AS PRESCRIBED BY THE HEP COMPENSATION ANALYSIS

	Channel Improvements Plan	Levee Plan
Acquisition Alternative	17,190.0 Acres	2,250.0 Acres
Restoration Alternative	9,076.0 Acres	1,836.0 Acres
Regeneration Alternative	5,850.0 Acres	1,950.0 Acres

The following table represents the compensation acreage that would be needed for each of the two (2) proposed plans under the assumption that the habitat losses for all the evaluation species would be fully compensated.

COMPENSATION ACRES REQUIRED TO OFFSET LOSSES OF TERRESTRIAL HABITAT ASSOCIATED WITH BOTH ALTERNATIVES TO FULLY OFFSET LOSSES TO ALL EVALUATION SPECIES

	Channel Improvements Plan	Levee Plan
Acquisition Alternative	31,293.9 Acres	5,122.0 Acres
Restoration Alternative	3,205.2 Acres	1,282.0 Acres
Regeneration Alternative	1,619.33 Acres	916.0 Acres

Under the Channel Improvements Alternative, the limiting evaluation species for the **Acquisition Alternative** would be the gray squirrel. Based upon the analysis, a total of approximately 31,293.9 acres of existing forestland would need to be purchased and placed under a long-term forest management plan and other management plan activities to insure that all habitat losses for all the evaluation species are compensated. Under the proposed Levee Alternative, a total of approximately 5,122.0 acres would need to be purchased and placed under management to compensate for habitat losses for all the evaluation species. Under this scenario, the gray squirrel is the limiting evaluation species.

Under the **Restoration Alternative**, the great egret is the limiting evaluation species for the proposed Channel Improvements Plan requiring approximately 3,205.2 acres of restoration of forested habitat. In comparison, a total of approximately 1,282.0 acres would need to be restored to fully compensate for terrestrial habitat losses for all the evaluation species for the proposed Levee Plan Alternative.

The third compensation management plan alternative, the **Regeneration Alternative**, would include the reforestation of bottomland hardwood forestland. This management plan alternative provides the most balanced approach to accomplishing full compensation for all the evaluation species based upon the recommended compensation areas as developed under the HEP compensation analysis format. For the proposed Channel Improvements Plan, a total of approximately 1,619.33 acres would need to be reforested to provide full compensation for habitat losses associated with all the terrestrial evaluation species. In the case of the proposed Levee Plan, a total of approximately 916.0 acres would need to be reforested to accomplish full compensation for habitat losses for all terrestrial species.

Based upon the analysis completed, it appears that the reforestation of existing agricultural lands to a bottomland hardwood forestland habitat type represents

the most balanced approach for compensation for the associated habitat losses for both the proposed structural alternatives. Under the HEP analysis guidelines, this alternative provides the most balanced approach and would appear to provide adequate compensation for terrestrial habitat losses associated with each of the two (2) proposed plans.

Aquatic Compensation Analysis

As previously noted, the 2006 Aquatic Evaluation completed by the ERDC Environmental Laboratory staff was utilized as a part of the updated HEP analysis for the current proposed structural alternatives. Though completed for the previous alternative, the Two Lakes Flood Control Plan, the information and findings of the 2006 evaluation are still pertinent for the current alternatives that are being evaluated. As such, an additional field assessment on the Pearl River through the proposed project area was not completed. Rather, the existing data was utilized and the 2006 Aquatic Evaluation was made an integral part of this HEP analysis process (Appendix C).

To remain consistent with the 2006 Aquatic Evaluation, the same HSI values were utilized to evaluate the post-construction aquatic habitat conditions.

Evaluation Species	Existing Conditions (Lacustrine, Riverine and Palustrine)			Post-Project Conditions (Lacustrine)			Percent Change in HUs
	Acres	HSI	HU	Acres	HSI	HU	
Black Crappie	634.44	0.80	507.55	1,904.52	0.88	1,675.98	2.30
Bluegill	634.44	0.80	507.55	1,904.52	0.79	1,504.57	1.96
Channel Catfish*	634.44	0.72	456.80	1,904.52	0.35	666.58	0.46
Common Carp	634.44	0.79	501.21	1,904.52	0.35	666.58	0.33
Largemouth Bass	634.44	0.95	602.72	1,904.52	0.95	1,809.29	2.00
Redear Sunfish	634.44	0.78	494.86	1,904.52	0.78	1,485.53	2.00
White Crappie	634.44	0.87	548.79	1,904.52	0.82	1,561.71	1.85

* The channel catfish is the only species that inhabits all three (3) assessed aquatic habitats.

As noted, the Channel Improvements Plan alternative would result in the more significant modifications to the existing aquatic habitats present within the project area in comparison with the Levee Plan alternative, which would not significantly modify or alter the current aquatic environments. Therefore, HUs were determined for the existing habitats using the published HEP Models for

each of the seven (7) fish species commonly found within the project area. It was assumed that all species utilized all of the aquatic environments within the project area during their life cycle. Based upon that assumption, an average HIS was calculated for each species across all the habitats.

As previously discussed, a total of approximately 634.44 acres of palustrine, lacustrine and riverine habitats would be impacted by the proposed Channel Improvements Plan. As a part of the project implementation, approximately 1,904.52 acres of lacustrine habitat would be created. As a final determination, the percent change in habitat units for each evaluation species was calculated by comparing the available HUs for the existing conditions relative to the available HUs with the post-construction conditions. As a result, the post-construction conditions would provide a percent increase in available HUs for each of the evaluation species utilized. These conditions would be provided due to the creation of a larger aquatic environment post-construction.

Based upon the analysis, the predominately lacustrine habitat species such as the black crappie had the largest percent increase in available habitat post-construction while the largemouth bass and redear sunfish would both have a similar increase in potential available habitat. At the same time, the common carp and the channel catfish both saw a decrease in the percent of available habitat post-construction which is primarily due to the transition from what are strictly riverine and palustrine environments to what would be a more lacustrine environment post-construction from an overall perspective. Given the fact that no net loss of HUs would be anticipated as a result of the project construction, it can be assumed that all the existing species would be present within the project area post-construction.

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