Pearl River Basin, Mississippi
Federal Flood Risk Management Project
Hinds and Rankin Counties, MS

FISH AND WILDLIFE COORDINATION ACT REPORT

U.S. FISH AND WILDLIFE SERVICE

ECOLOGICAL SERVICES

LAFAYETTE, LOUISIANA

January 2020

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January 7, 2020

Mr. David Walther, Supervisor
U.S. Fish and Wildlife Service
200 Dulles Drive
Lafayette, LA 70506

RE: *One Lake Project draft FWCAR*

Dear Mr. Walther:

The professional staff of the Louisiana Department of Wildlife and Fisheries (LDWF) has reviewed the above referenced draft Fish and Wildlife Coordination Act Report. Based upon this review, the following has been determined:

General Comments and Concerns:
LDWF agrees with the Service's findings and position. Like USFWS, LDWF is not opposed to providing flood protection to Jackson, Mississippi and the surrounding areas; however, we too have concern with the tentatively selected plan (TSP) presented. We appreciate that USFWS is encouraging the sponsors to select a less damaging array of alternatives.

We support USFWS's proposed alternative of Alternative B with additional features. Notwithstanding, if extensive channel improvement is determined to be necessary, we believe that the sponsors should explore variations of and significant modifications to the TSP to greatly reduce impacts to fish and wildlife resources. For example, if such an activity is justified, in addition to the alternatives described by USFWS, we believe a dry dam(s) alternative without an associated permanent impoundment (i.e., lake) should be explored. Such an option may meet the project flood risk reduction objectives within a reduced footprint. With a properly designed bottom outlet set at the original river bed level remaining open under most/all conditions, it may also allow for fish passage, sediment transport, ecosystem continuity, maintain riverine habitat otherwise lost (compared to the current TSP), and lessen other associated negative environmental impacts. Lempérière, F. (2006) states 'Future dams may generally be multipurpose, but dams devoted only to flood mitigation which are completely dry except for a few weeks per century may be very acceptable environmentally; their design may be quite different from multipurpose dams and their cost much lower for the same storage'.

We too believe that an approach which includes separate riverine mitigation concepts should be utilized. Riverine impacts should be fully mitigated, and mitigation should occur within the Pearl River Basin. Such mitigation could include reclamation of existing sand and gravel mines downstream of the project. We believe that in addition to the main stem of the river, its downstream distributaries should be given priority as well. LDWF would be happy to provide assistance in locating/reviewing potential mitigation sites in Louisiana.

LDWF is concerned with geomorphological impacts resulting from decreased sediment transport resulting from the TSP. The coordination report states that potential channel instability, erosion, deepening, etc., may extend up to 1.6 miles downstream of the project site. Nonetheless, we believe that monitoring of sandbars, stream banks and beds should occur well downstream of the 1.6 mile mark to ensure that any resulting, downstream geomorphological impacts are assessed and mitigated.

Inland Fisheries Concerns:
When considering mitigation for unavoidable losses of fish and wildlife habitat, as reflected by loss of Average Annual Habitat Units (AAHUs) and the conservation of migratory and federally listed species, projects throughout the basin that afford the greatest positive impact to Gulf Sturgeon and other migratory fish should be prioritized. Strong consideration should be given to mitigation projects such as unencumbering passage at the Pools Bluff sill and the Bogue Chitto sill.

In addition to SGCN fish species shared between LA and MS, LDWF is including a list of LA SGCN fish that could possibly be impacted by the project.

LA SGCN not listed in Table 3 that occur in the Basin and may be affected by proposed actions

Species	LA Status
American Eel (*Anguilla rostrata*)	S4
Clear Chub (*Hybopsis winchelli*)	S3
Shoal Chub (*Macrhybopsis hyostoma)**	S3
Longjaw Minnow (*Ericymba amplamala*)	S3
Redspot Darter (*Etheostoma artesiae*)	S3
Saddleback Darter (*Percina vigil*)	S3

**M. hyostoma* is now *M. tomellerii* in the Pearl River Basin, but the LA State Wildlife Action Plan is in the process of revising the nomenclature.

Marine Fisheries Concerns:
The productivity of oyster (*Crassostrea virginica*) reefs in Mississippi Sound (Halfmoon Island, Grassy Island, Petit Island, Grand Banks) depends on the mixing of fresh water from the Pearl River with salt water from the Gulf of Mexico to maintain a salinity range of 5 – 15 parts per thousand. The reduction or disturbance of fresh water flow from the Pearl River may upset the established balance, and a more saline environment would in turn cause devastating consequences to existing oyster populations. Without the influx of cooler fresh river water, estuary water temperature, salinity, and pH ranges in the area could be permanently altered. Oysters are more susceptible to oyster Dermo disease (*Perkinsus marinus*) in higher water temperatures and salinities; oysters are more susceptible to predation from, Southern Oyster Drill (*Stramonita haemastoma*), in higher water temperatures and salinities; and high salinity Gulf water will travel further into the estuary exacerbating hypoxic events.

Oysters need hard, clean substrate to attach to. Reefs build upon themselves over seasons (to overcome sedimentation) which provides additional habitat to a variety of fish, shrimp and other organisms. The potential shift in fresh to saltwater ratios would decrease oysters' food supply and shift the optimal salinity waters into areas that may lack adequate substrate or adequate food for oysters to reestablish. The proposed flood control project may decrease the ability for oysters to thrive on established reefs. The potential ripple effect of loss of reef habitat would be felt throughout many fisheries. Local recreational and commercial (shrimp/crab) fishermen depend on the freshwater feeding the productive brackish marshes and viable oyster reefs. Additionally, nutrient load/effluent in the river water may be affected if there is a reduced rate of flow. If there is a reduction in river flow, there may be potential for reduced carrying capacity and a limited opportunity for the dilution of potentially harmful materials carried by the river. Elevated contaminate loads may cause existing oysters reefs influenced by the Pearl River to be closed and remain closed for harvesting.

LDWF Marine Fisheries recommends that the proposed long-term water quality monitoring associated with this project include at least one site in the Mississippi Sound, possibly at LDWF's Halfmoon Island station (30.11944, -89.43194), or another location(s) in the Sound agreed upon by LDWF.

The Louisiana Department of Wildlife and Fisheries appreciates the opportunity to review and provide recommendations to you regarding this proposed activity. Please do not hesitate to contact Habitat Section biologist Matthew Weigel at 985-543-4931 should you need further assistance.

Sincerely,

Kyle F. Balkum
Biologist Director

mw/rm/cw

EXECUTIVE SUMMARY

This final Fish and Wildlife Coordination Act (FWCA) report provides an analysis of the impacts on fish and wildlife resources that would result from flood control measures, recommendations to mitigate those adverse impacts, and planning objectives for the Pearl River Basin, Mississippi, Federal Flood Risk Management Project, Hinds and Rankin Counties, Mississippi (commonly referred to as the Jackson Metropolitan Flood Control Project or One Lake Project). The purpose of the project is to decrease the flood risk for the greater metropolitan area of Jackson, Mississippi. The draft Feasibility Study and Environmental Impact Statement (FS/EIS) was developed and released on June 23, 2018, for public review by the Rankin Hinds Pearl River Flood and Drainage Control District (District). Previous flood control studies conducted by the U.S. Army Corps of Engineers, Vicksburg District (USACE) were authorized by various Congressional actions; however, Section 3104 of the Water Resources Development Act (WRDA) of 2007 modifies Section 401 (e)(3) of WRDA 1986 authorizing the Assistant Secretary of the Army for Civil Works (ASACW) to construct a project. The latest authorization for this study, Section 1322(b)(4)(A) of the Water Infrastructure Improvements for the Nation Act (Public Law 114-322;WIIN Act), continues the project's status as a Congressionally authorized project and affirms the project's history, as originating in Section 401(e)(3) of WRDA 1986 and modified by Section 3104 of WRDA 2007. This preserves the project's authority and status under the provisions of Section 211 of WRDA 1996, and directs the Secretary of the Army to "expedite review and decisions on recommendations" for the project.

This FWCA report has been provided to the Mississippi Department of Wildlife, Fisheries and Parks (MDWFP), the Louisiana Department of Wildlife and Fisheries (LDWF), and the Mississippi Department of Marine Resources (MDMR) for comment and their comments are attached and have been incorporated into this final FWCA report. This report is submitted in accordance with the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661-667e) and constitutes the report of the U.S. Fish and Wildlife Service (Service) as required by Section 2(b) of the FWCA.

Subsequent to the public release of the Draft Integrated Feasibility Study and Environmental Impact Statement, the Service under the authority of the FWCA, worked with the representatives for the non-Federal sponsor to address conservation goals and recommendations. Ongoing and additional investigations since the release of that document have provided additional information regarding the degree and magnitude of potential impacts. Incorporation of conservation measures into the project was also accomplished, thus the Service's concerns and recommendations are based upon those investigations and a revised project description.

The Pearl River Basin drains over 8,590 square miles in central Mississippi. The Pearl River Basin Study area consists of the Pearl River floodplain from the Ross Barnett Dam to just south of Byram and includes land in Madison, Rankin, and Hinds Counties, Mississippi. Immediately upstream of Jackson and on the Pearl River at River Mile (RM) 301.77 is the Ross Barnett Reservoir. The Pearl River Valley Water Supply District (PRVWSD) constructed that reservoir in the mid-1960s, and they retain authority for operation and maintenance of the project. The Ross Barnett Reservoir almost entirely removed the upper one-third of the drainage basin from contributing sediment to the riverine ecosystem. Incision and degradation of the Pearl and

Strong rivers has been reported as being caused by the reservoir, however, not all investigations agree that such impacts resulted from that reservoir or if they have, they claim that the system may have since stabilized.

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 and channel cutoffs, 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. Some of these were created in the 1960's when the river was channelized for flood control and portions of the river were isolated. 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. Development has reduced the quality of some of the forested areas and aquatic habitats. Previously completed flood control work (floodplain clearing and channelization and levee construction) within the project area has altered the Pearl River floodplain and riverine habitat.

The District examined three alternatives in the final array: a nonstructural alternative, a levee plan, and a channel improvement/weir/levee plan (channel improvement alternative). Alternative A, the nonstructural alternative consists of relocations and buyouts to achieve flood control. Alternative B, the levee alternative consists of new levees or floodwalls, expansion of existing levees, and new pump stations. Alternative C, the channel improvement alternative consists of deepening of the floodplain, relocation of levees, and construction of a weir at the downstream end of the project area.

The tentatively selected plan (TSP or Channel Improvement Alternative or One Lake), referred to as Alternative C, consists of excavation of approximately 25 million cubic yards from the floodplain, extending from River Mile (RM) 284.0 to RM 293.5 (approximately 9.5 miles), and ranging in width from 400 to 2,000 feet. Some existing levees will be set back and new levees constructed with large amounts of fill areas placed behind them. The elevated land mass behind the levees will range from 200 to over 1,000 feet in width. To maintain water supply at the J. H. Fewell Water Treatment Plant (WTP) located at RM 290.7, an approximately 1,500-foot-long weir will be constructed at RM 284, creating a 1,500-acre pool area at the downstream limits of the project area and providing flood risk management benefits, recreation, and long-term maintenance reduction. The approximately 200-foot-wide existing weir at the J.H. Fewell WTP will be removed. Islands will be created from RM 289.5 to RM 292.0, some of which will be used to maintain and create habitat areas for local species. This alternative was selected because of the flood risk reduction provided to the Jackson metropolitan area, the maintenance of traffic flow during such events and the maintenance of flow releases from the Ross Barnett Reservoir also during those events. The project is designed to reduce the risk of damages from the one percent (1%) flood event (i.e., 100-year flood event); therefore, it would not provide complete flood protection for a flood equivalent to the "Easter" Flood of 1979, which was a 200-year event, but it would reduce flood damages by approximately 80 percent.

The adverse impacts from a weir on riverine functions differs from that of large dams, with weirs producing more localized and smaller scaled impacts. Nonetheless, conversion of riverine habitat to a predominantly lake habitat with the resulting loss of riverine dependent species, localized downstream bank and river bottom instability due to reduced sediment transport and a degree of segregation of aquatic animal populations is typical (Cumming 2004; Fencl et al., 2015; Fencl, et al., 2017; Haponski, et al., 2007; Santucci, et al., 2005). Alternative C would affect 2,856.62 acres of various habitat types, including approximately 10 miles of riverine habitat of various habitat quality. Of that acreage, approximately 1,314.8 acres are wetlands dominated by bottomland hardwoods with some swamp and shrub/scrub (shrub land) habitat.

Impacts associated with the proposed weir would include those described above. The upstream pool would likely capture any coarser sands entering the pool and would retain some finer grain sizes; however, as grain size decreases the likelihood of retention would decrease. The net loss of this sediment would likely result in geomorphological instability extending up to 1.6 miles downstream of the proposed weir. Bank erosion and channel deepening would likely occur up to 1.6 miles downstream, further degrading the altered system. Those resulting impacts would likely result in decreased habitat quality for six at-risk species and other riverine dependent aquatic species resulting in further population declines. Planned fish passage around the weir would provide migration opportunities for such fish species as the Gulf sturgeon, American shad, American eel, and southeastern blue sucker. Additional, details regarding the fish passage design would be developed in future detailed planning efforts.

Species listed under the Endangered Species Act that are found in the area include the threatened ringed map (formerly known as the sawback) turtle (*Graptemys oculifera*), which is endemic to the Pearl River system. The Atlantic or Gulf sturgeon (*Acipenser oxyrhynchus desotoi*), federally listed as a threatened species, is an anadromous fish that occurs in the Pearl River; critical habitat within the Pearl River is designated from the tailwaters of the Ross Barnett Reservoir to the Gulf of Mexico. The threatened wood stork (*Mycteria americana*) occurs seasonally in Mississippi during the non-breeding season (May-October) typically foraging in freshwater marshes, swales, ponds, hardwood and cypress swamps, narrow tidal creeks or shallow tidal pools, and artificial wetlands. Federally listed as a threatened species, the Alabama heelsplitter mussel (*Potamilus inflatus*) no longer occurs in the project area but may still be found downstream in the West Pearl River drainage. The project area is within the range of the northern long-eared bat (*Myotis septentrionalis*), but there are no records of this species in the project area.

For the Levee Alternative, referred to as Alternative B, land would be required for the levees, floodgates, and required project rights-of-way as well as for borrow pits. This alternative would affect 785.8 acres of habitat with most occurring in forested wetland areas. Overall, the acreage of impacts associated with the Channel Improvement Alternative is 1,955.24 acres greater than that associated with the Levee Alternative; however, the Channel Improvement Alternative accomplishes a greater reduction of flood damages based on flood events ranging from the 2-year through 500-year events.

The Service acknowledges the need for flood control within the Jackson Metropolitan Area and the many studies through the years that have produced numerous and various alternatives and plans. Some of the identified plans could not be implemented due to objections or non-support. In this study, re-consideration of those alternatives was undertaken in addition to the formulation of new and various other alternatives and features. Those alternatives also included some new features (e.g., channel improvements [secondary high flow channel], and levee relocation). However, the combinations of those alternatives did not include all combinations (e.g., levee set back) or varying degrees of features that could potentially decrease impacts to fish and wildlife habitat and provide some level of flood control. An analysis of the additional re-combinations or variations of features (e.g., other weir heights, relocations of levees) would provide clarity in defining and ensuring the least damaging alternative. Therefore, the Service has proposed the addition or modification of other features to the Levee Alternative that should help increase the level of flood protection provided and aid fish and wildlife conservation. Widening of the floodplain via levee setbacks (as included in the Channel Improvement Alternative) would restore some wetland functions to isolated wetlands and has the potential to reduce flood stages. Implementing conveyance improvements at flow impediments within the floodplain (e.g., transportation embankments). Lowering of the floodplain surface within the existing mowed and channelized areas and other areas where passage of flows is restricted, or where floodplain features prevent a more lateral dispersal of flood waters, or where topography reduces the floodplain capacity, could also reduce flood stage elevations. Use of passive flood barriers or temporary deployable barriers to reduce flooding impacts to roadways could also be examined. Other features could also be included as needed to protect infrastructure, especially critical infrastructure (e.g., wastewater facilities). These modifications to Alternative B would likely further improve flood protection, however, the Service does not determine flood risk reduction benefits so the degree of risk reduction they would provide is unknown. Furthermore, the Service does not know the degree to which these modifications would achieve the projects planning objectives but examination of such combinations is warranted. Variations of the TSP where the weir height or amount and/or extent of excavation needed to achieve project purposes was not presented. Such weir modifications may have the potential to reduce impacts while still maintaining a high degree of flood risk reduction.

The determination of compensation areas for terrestrial impacts using the Habitat Evaluation Procedures (HEP) contemplated three alternative management scenarios: acquisition, restoration, and regeneration. The acquisition alternative includes acquisition of existing forestland and preservation of existing habitats via a long-term management plan. The restoration alternative assumes that every existing habitat type found within the project area would be restored at some other location within the Pearl River Basin. The regeneration alternative includes the regeneration of the dominant habitat type within the proposed project areas. Under this 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 acreage required to mitigate for the Channel Improvement Plan using the acquisition, restoration, and regeneration scenarios of the in-kind goal (each evaluation species losses are offset) and the equal replacement goal (all lost habitat units are offset) are presented below (Table 1). However, it has not been determined if this plan would fully mitigate AAHUs lost by riverine species, because the HEP species selected did not represent riverine guilds. Therefore, modification of the mitigation plan may be necessary during detailed design and construction phases. Aquatic mitigation measures could include those identified by ERDC, LDWF, and Kennedy and Hasse (2009).

Table 1. Acres required for mitigation.		
Acres required to mitigate impacts using the in-kind mitigation goal.		
Mitigation strategy	**Channel Improvement Plan**	**Levee Plan**
Acquisition	31,293.9	5,112
Restoration	3,205.2	1,282
Regeneration	1,619.33	916
Acres required to mitigate impacts using the equal replacement mitigation goal		
Acquisition	17,190	2,250
Restoration	9,076	1,836
Regeneration	5,850	1,950

Impacted riverine species would benefit from the proposed protection of 10 miles of riverbank and other aquatic features developed during the ESA consultation. However, the adequacy of these measures to fully mitigate riverine impacts has not been determined. Therefore, modification of the mitigation plan may be necessary. Riverine mitigation measures could include stabilization of eroding banks, or those identified by LDWF (sand and gravel mile restoration and sill removal) or the Engineering Research and Development Center. While a mitigation plan has been developed because the exact site of the mitigation has not been identified the mitigation scenarios presented lack specificity that would allow the Service to fully determine whether they are acceptable. Inclusion of the following detailed components in the plan should aid the Service in determining the likelihood of mitigation success:

1) criteria for determining ecological success;
2) monitoring until after successful completion;
3) a description of available lands for mitigation and the basis for the determination of availability;
4) the development of a contingency plan (i.e., adaptive management);
5) identification of the entity responsible for monitoring; and
6) establishment of a consultation process with appropriate Federal and State agencies to determine acceptable means of mitigation and success criteria.

By choosing Alternative C, the channel improvement plan, the District has selected the most environmentally damaging alternative of those analyzed in the draft Feasibility Study and Environmental Impact Statement (FS/EIS). Since there are unavoidable losses of wildlife resources associated with that alternative, habitat compensation is appropriate. The Service provides the following recommendations for Alternatives C, the channel improvement plan, and B (the levee plan) with Service proposed modifications. Consideration of each recommendation should be undertaken to ensure compliance with the equal consideration clause of the FWCA. The recommendations for Alternative B would also apply to that alternative even with the Service's proposed modifications being incorporated.

<u>For the Channel Improvement Alternative (TSP)</u>:

1. Ensure that the least damaging alternative has been selected.

2. Mitigation should be implemented concurrent with construction.

3. Mitigation for unavoidable losses of fish and wildlife habitat, as reflected by loss of Average Annual Habitat Units (AAHUs) should be done within the Pearl River Basin. Detailed mitigation plans should be developed and coordinated with the natural resource agencies. At minimum the plan components should include:
    a. criteria for determining ecological success ;
    b. monitoring until after successful completion;
    c. a description of available lands for mitigation and the basis for the determination of availability;
    d. identification of the entity responsible for monitoring;
    e. development of a contingency plan (i.e., adaptive management); and
    f. establish a consultation process with appropriate Federal and State agencies to determine acceptable means of mitigation and success criteria.

4. During low-flow periods, including droughts, a minimum flow of 170 cubic feet per second should be maintained even if water levels fall below target pool elevations, matching the discharge from the Ross Barnett Reservoir. At all other times the flow should discharge sufficient water to meet the needs of the Savanna Street Wastewater Treatment Facility (i.e., 225 cubic feet per second).

5. When filling the pool, the downstream flow should at least maintain the minimum required discharge from the Ross Barnett Reservoir, while also allowing portions of flood flows to pass downstream.

6. Mitigation for riparian, sand bar, and riverine impacts should be combined to help achieve some cost-effectiveness. Selection of mitigation sites and development of mitigation plans should be done in coordination with the natural resource agencies. During consideration of mitigation sites, recovery goals for threatened species within the project area should be considered as well as habitat that would help conserve at-risk species. Location of mitigation areas downstream of the project area would aid in the conservation of at-risk species; however, mitigation upstream of the Ross Barnett Reservoir is acceptable. Other additional mitigation features that could be considered include riverbank protection/stabilization in areas that are experiencing instability, gravel bar protection/restoration, sand and gravel mine restoration, and sill removal.

7. Long-term water quality and quantity monitoring up and down stream and within the expanded channel should be undertaken pre- and post-construction. Measured parameters should include at minimum temperature, dissolved oxygen (DO), total suspended sediments, nitrogen, pH, fecal coliforms, velocity, discharge, and water levels, as well as other physical and chemical parameters necessary to maintain the life cycle of selected aquatic species. This water quality-monitoring plan should be developed in cooperation with the natural resource agencies and should be used to ensure aquatic AAHUs mitigated by the pool are achieved. This would aid in complying with ER 1110-2-8154; engineer regulation on water quality.

8. In consultation with the natural resource agencies, a plan should be developed to identify and designate shoreline usage areas within the project area, as well as down and upstream areas influenced by the project. Designations should include: 1) limited development, 2) public recreation, 3) protected shoreline, and 4) prohibited access areas (e.g., public safety). This would help ensure that fish and wildlife mitigation, including minimization, associated with the project are maintained and would aid in complying with ER 1110-2-8154.

9. Sediment testing for contaminants is recommended in areas proposed for use as borrow or that would be flooded by the project, especially those around known contaminated areas that are proposed for use in levees, berms, or islands, where contaminant exposure to fish and wildlife is probable. The testing and response plan for any contaminated soil should be developed in cooperation with the natural resource agencies.

10. To minimize adverse impacts to migratory fish species the design of the fish passage should be coordinated with the natural resource agencies.

11. Development of an operational plan to aid sediment flushing.

12. A monitoring and adaptive management plan addressing upstream and downstream geomorphology impacts should be developed to determine the need to implement grade or other erosion control (e.g., bank stabilization, etc.) features to minimize project impacts to the Pearl River and its tributaries. That plan should include at minimum the use of aerial photographs, geographical information systems, gauge and cross-section data, as well as other parameters deemed necessary during development of that plan. The plan should be developed in cooperation with the natural resource agencies. Monitoring may result in the determination of additional monitoring and/or mitigation needs from such impacts; the plan should incorporate a request for pre-authorization for such mitigation in the event that it is determined necessary.

13. An invertebrate and fishery monitoring plan should be developed to ensure that all impacts to the project have been mitigated and that mitigation features (e.g., river restoration, etc.) are functioning as intended. This long-term plan should incorporate various gear types (e.g., electro-shocking, seines, gill nets, etc.) to maximize the detection of various riverine guild species most susceptible to water resource development projects and should be cost-shared as a project feature. That plan should be developed in cooperation with the natural resource agencies.

14. Creation and reforestation of a riparian zone along the toe of the levee, especially adjacent to the created sand bars should be undertaken where feasible to provide riparian habitat and provide erosion protection to the fill areas. To provide erosion protection the width would need to be approximately 300 feet; this would be advantageous to wildlife as well but narrower widths could also provide useable wildlife habitat.

15. Impacts to the public lands, such as LeFleur's Bluff State Park, and other conservation lands (Fannye Cook Natural Area) should be avoided and minimized. Mitigation for such impacts should be located on public lands or property that is placed into the public trust.

16. A conservation easement, in perpetuity, should be recorded on the deed of any mitigation site.

17. Incorporate sediment and erosion control measures during construction and re-vegetate all disturbed areas immediately following construction.

18. In order to ascertain the validity of the HEP analysis the Service requests that an inter-agency review be conducted of the assumptions by target years and suitability indices; such reviews can ensure the proper application of models and the calculation of impacts and mitigation.

19. The Engineering Research and Development Center (ERDC) previously assessed impacts to lacustrine, backwater, and riverine species and habitats separately (Appendix C in the Environmental Appendix, i.e., Appendix D) and formulated separate riverine impacts and mitigation concepts. The Service endorses and supports the mitigation and impact analysis approach and the mitigation measures for Alternative C to ensure riverine habitat impacts are fully mitigated.

20. A comprehensive assessment of changes in the Pearl River Basin's hydrology and land uses should be conducted to determine their influence on flooding and the ecosystem response with a goal of identifying and developing ecosystem restoration projects that can reduce flood risk throughout the Basin.

21. The Service and other natural resource agencies should be coordinated with during the next planning and construction phases as project details are developed.

22. LDWF has concerns regarding the loss of any flows and the resulting potential changes to water quality, especially salinities, within the northwestern portion of the Mississippi Sound. Therefore, they recommend a water quality station be established at Half Moon Island. Details regarding water quality parameters and location should be developed with the LDWF Marine Fisheries staff.

<u>For Alternative B with Service proposed modifications</u>:

1. Mitigation for unavoidable losses of fish and wildlife habitat, as reflected by loss of Average Annual Habitat Units (AAHUs) should be done within the Pearl River Basin. Detailed mitigation plans should be developed and coordinated with the natural resource agencies. At minimum, the plan components should include:
    a. monitoring until after successful completion;
    b. criteria for determining ecological success;
    c. a description of available lands for mitigation and the basis for the determination of availability;
    d. identification of the entity responsible for monitoring;
    e. development of a contingency plan (i.e., adaptive management); and

f. establish a consultation process with appropriate Federal and State agencies to determine acceptable means of mitigation and success criteria.

2. Borrow pits should be designed to improve fish and wildlife habitat and to enhance recreational opportunities as described in the USACE 1986 report entitled, "Environmental design considerations for main stem levee borrow areas along the lower Mississippi River."

3. Incorporate sediment and erosion control measures during construction of the levees and re-vegetate all disturbed areas immediately following construction.

4. Monitor sandbars in the Pearl River upstream, and downstream of the project area to determine net changes in size and availability of sand bar habitat as affected by changes in river hydrology. Details of this monitoring effort, including duration, should be coordinated with the natural resource agencies and should include remote sensing, field inspection/surveys, and river gauge data.

5. Continue the limited use of herbicides in the maintenance of the overbank and floodway cleared areas.

6. Limit the removal of vegetation in the project area to that necessary for the construction and maintenance of project flood control features.

7. Restrictive use zoning or non-development easements should be implemented by the local sponsor, prior to project construction, and contain language stringent enough to ensure that flood-prone development does not occur and that undeveloped lands in the floodplain are used for floodwater storage, wildlife, outdoor recreation, and other flood compatible land uses.

8. A conservation easement, in perpetuity, should be recorded on the deed of any mitigation site.

9. Levee setbacks, as proposed for Alternative C, are recommended to widen the floodplain and reduce flood stage elevations.

10. Excavation of the cleared floodplain to a lower elevation that would reduce water surface elevations while still allowing maintenance mowing is proposed. This could also be implemented in other areas where passage of flows is restricted, floodplain features prevent a more lateral dispersal of flood waters, or topography reduces the floodplain capacity. This should lower flood stages within these areas. Excavated soils, if suitable, should be used in levee construction. Floodplain excavation could also include removal of the floodplain portion of the Gallatin Street landfill near RM 285, a site identified in the draft FS/EIS that could be leaching chemicals into the groundwater and potentially into the Pearl River and its floodplain.

11. Conveyance improvements could be implemented around transportation embankments and lowering of the floodplain elevation in those areas could also be done.

12. If needed, additional borrow material could be taken from within the cleared floodplain but those sites should be located where they will not become permanently connected to the river.

13. The Service and other natural resource agencies should be coordinated with during the next planning and construction phases as project details are developed.

SUMMARY OF FINDINGS AND SERVICE POSITION

The Service Mitigation Policy (Federal Register, Vol. 46, pp. 7644-7663, January 23, 1981) is specific in its guidance pertaining to formulation of an official position relative to a given water development project. In essence, a project must meet the five criteria presented below in order to gain Service approval.

1) Proposals are ecologically sound.
2) The least environmentally damaging reasonable alternative is selected.
3) Every reasonable effort is made to avoid or minimize damage or loss of fish and wildlife resources and uses.
4) All important recommended means and measures have been adopted with guaranteed implementation to satisfactorily compensate for unavoidable damage or loss consistent with the appropriate mitigation goal.
5) For wetlands and shallow water habitats, the proposed activity is clearly water dependent and there is a demonstrated public need.

The Mitigation Policy also provides explicit guidance regarding formulation of the Service position regarding a given project:

> "The Service may recommend the 'no project' alternative for those projects or other proposals that do not meet all of the above criteria and where there is likely to be a significant fish and wildlife resource loss."

The Service is not opposed to providing flood protection to Jackson and the surrounding area; however, in accordance with the above provisions, the Service currently has concerns regarding implementation of the Tentatively Selected Plan as proposed in the Pearl River Basin, Mississippi, Federal Flood Risk Management Project, Rankin and Hinds Counties, Mississippi Project. The reasons for our concerns, which address the five criteria presented above, are provided below:

1. As currently proposed the weir would impede aquatic species movement for an additional 18 miles upstream and would convert approximately 9.5 miles of riverine habitat to lacustrine habitat for approximately six months of each year. Some at-risk species and other aquatic species that are more dependent on riverine habitat would no longer persist at current population levels due to that habitat conversion. A fish passage would mitigate impacts of the weir but monitoring and adaptive management would be warranted.

2. The TSP is the most damaging alternative for both terrestrial and aquatic resources. The Service's proposed modifications to Alternative B could provide flood protection with reduced impacts to terrestrial and aquatic resources, however, the actual flood risk reduction benefits are not known because the array of alternatives did not feature such combinations. Variations of the TSP (e.g., weir heights, amount and/or extent of excavation) are not presented within planning documents.

3. The Service has provided recommendations within the draft and final FWCA reports that would aid in avoiding and minimizing impacts to fish and wildlife resources and uses. Incorporation of those recommendations would aid in complying with this criterion. Various flood risk reduction features were proposed in several of the alternatives however, incorporation of those alternatives into the final array of alternatives was not examined. Variations of the TSP that may have reduced impacts to fish and wildlife resources were not presented in the planning documents. The Service's proposed modifications to Alternative B represent a potentially feasible alternative to achieve avoidance and minimization while still meeting the project goals. The lack of specificity within the mitigation plan precludes the Service from determining if the proposed mitigation would fully compensate fish and wildlife losses, however, the Service understands additional mitigation planning is ongoing.

4. Within the USACE planning process typically teams are developed to guide that process. As this study was not conducted in that manner, the Service was not fully involved and able to provide recommendations and conservation measures that could have been adopted early in the planning process. The Service did participate in meetings and was engaged via discussions throughout the later part of the planning process (i.e., a preliminary draft EIS was already prepared). Addressing the above Service recommendations within the final FS/EIS should assist in complying with this criterion.

5. There is a demonstrated need for flood protection within the Jackson area; however, the need for the proposed Channel Improvement Plan in-lieu of other possible flood control alternatives that maybe less damaging has not been clearly demonstrated.

If Alternative C is selected for implementation, the Service requests that all of our recommendations be incorporated into the project plans to ensure compliance with the FWCA. The Service looks forward to our continued work with the District to address the flood risk reduction needs of Jackson and the surrounding area.

INTRODUCTION

This final Fish and Wildlife Coordination Act (FWCA) report provides an analysis of the impacts on fish and wildlife resources that would result from flood control measures, recommendations to mitigate those adverse impacts, and planning objectives for the Pearl River Basin, Mississippi, Federal Flood Risk Management Project, Hinds and Rankin Counties, Mississippi Project (also referred to as the Jackson Metropolitan Flood Control Project or One Lake). The purpose of the project is to decrease the flood risk for the greater metropolitan area of Jackson, Mississippi. The Rankin-Hinds Pearl River Flood and Drainage Control District (District) developed a draft Integrated Feasibility Study and Environmental Impact Statement (FS/EIS) and released it for public review on June 23, 2018. Previous flood control studies conducted by the U.S. Army Corps of Engineers, Vicksburg District (USACE) were authorized by various Congressional actions, however in Section 3104 of the Water Resources Development Act (WRDA) of 2007 that modifies Section 401 (e)(3) of WRDA 1986 authorize the Assistant Secretary of the Army for Civil Works (ASACW) to construct a project generally in accordance with the plan described in the Pearl River Watershed, Mississippi, Feasibility Study Main Report, Preliminary Draft, dated February 2007. The latest authorization for this study, Section 1322(b)(4)(A)) of the Water Infrastructure Improvements for the Nation Act (Public Law 114-322;WIIN Act), continues the project's status as a Congressionally-authorized project; affirms the project's history as originating in Section 401(e)(3) of WRDA 1986 and modified by Section 3104 of WRDA 2007; preserves the project's authority and status under the provisions of Section 211 of WRDA 1996; and directs the Secretary of the Army to "expedite review and decisions on recommendations" for the project.

The U.S. Fish and Wildlife Service (Service) provided a draft FWCA report to the Mississippi Department of Wildlife, Fisheries, and Parks (MDWFP), the Louisiana Department of Wildlife and Fisheries (LDWF), and the Mississippi Department of Marine Resources (MDMR) for comment. The Service has incorporated their comments in this final FWCA report. This final report is submitted in accordance with the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661-667e) and constitutes the report of the Secretary of the Interior as required by Section 2(b) of the FWCA.

The Service has been involved in the past flood control studies undertaken by USACE; however, Service involvement under the FWCA for the current planning efforts were not initiated until later in the planning process (completion of a preliminary draft FS/EIS). Much of the information about the proposed project features has been taken from planning documents, the draft FS/EIS, as well as the District's January 17, 2019, letter regarding our November 2018 draft FWCA report and ongoing coordination.

DESCRIPTION OF STUDY AREA

The Pearl River is formed in Neshoba County, Mississippi, by the confluence of Nanaway and Tallahaga Creeks and flows southwesterly for 130 miles to the vicinity of Jackson, then southeasterly for 233 miles to its outlet channels, the East Pearl and West Pearl Rivers. The Pearl River Basin drains over 8,590 square miles (Lee 1985). The Pearl River Basin Study area consists of the Pearl River floodplain from the Ross Barnett Dam to just south of Byram and includes land in Madison, Rankin, and Hinds Counties, Mississippi. The study area is drained by several small creeks that are tributaries of the Pearl River. These include Town, Hanging Moss, Eubanks, Lynch, Richland, Hardy, Caney, Purple, and Hog Creeks.

Immediately upstream of Jackson and on the Pearl River at River Mile (RM) 301.77 is the Ross Barnett Reservoir. The Pearl River Valley Water Supply District (PRVWSD) constructed the reservoir in the mid-1960s, and they retain authority for operation and maintenance of the project. The relatively shallow impoundment (mean depth of 12 feet) inundated approximately 24 miles of the Pearl River, and the normal pool covers approximately 33,000 acres. Water within the reservoir is dedicated to water supply for Jackson and to water-based recreation. In the north part of Jackson, the City of Jackson built a low weir (Lowhead Dam) in 1915 at approximately RM 290.7 for water supply, which still provides a large portion of the city's water supply even though the Ross Barnett Reservoir was also built for water supply.

The 1960 Flood Control Act authorized construction of the Jackson (i.e., Fairgrounds) and East Jackson levees to address flooding in the area; the USACE completed that project in 1968. An extension of the Jackson levee at Fortification Street was completed in 1984. The existing flood control project consists of two earthen levees (one located on either side of the river) totaling 13.2 miles, four gated outlet structures, and two pumping plants. The Fairgrounds levee is located in Hinds County and is designed to protect a portion of the city of Jackson on the west bank of the Pearl River. The East Jackson levee is located in Rankin County and is designed to protect all or parts of the communities of Pearl, Flowood, and Richland.

There is also channel work associated with the levees, which includes a 2.1-mile-long floodway along Richland Creek, a 3.7-mile-long diversion canal along Prairie Branch, and 9.3 miles of enlargement and realignment of the main river channel. Those features were designed to protect over 6,000 acres of former floodplain from the 100-year flood. The District is responsible for operation and maintenance of that project. Maintenance includes any necessary repairs to the levee structures and periodic removal of vegetation along a 650-foot-wide cleared strip of floodplain between the levees. In addition, the Four-Point Plan consisted of clearing the floodway from Old Brandon Road at RM 287.5 to RM 284.25; excavation of sediment and debris at the Highway 25 crossing of the Pearl River; construction of a wave barrier in the Ross Barnett Reservoir to prevent a premature failure of the fuse plug emergency spillway; and a river bend cutoff. The first two items have been completed, and the last two items have been removed from the plan.

Although the Ross Barnett Reservoir was not built for flood control, it played a key role in reducing the severity of the 1979 flood of record. Where State Highway 43 crosses the upper reservoir area, only two small bridge structures allow the passage of water along the entire length of the crossing. These openings restrict the amount of water, which can flow into the main impoundment and downstream. Thus, the highway crossing also functioned to retard floodwater passage, which resulted in increased upstream flooding, but decreased flood stages downstream. This factor, along with a minor amount of flood storage potential (approximately 1 foot) at the Ross Barnett Dam, effectively reduced the 500-year flood of April 1979 to a 200-year event at Jackson. The Ross Barnett Reservoir has tried to reduce downstream flood events by prereleasing flows within the design limitations, but with a limited flood storage potential this does not provide significant flood risk management for the Jackson Metropolitan area.

Other roads that influence the water surface elevation in the same manner as State Highway 43, but downstream of the reservoir, include State Highway 25 (i.e., Lakeland Drive), Old Brandon Road, U.S. Highway 80, and Interstate Highways 55 and 20. The railroad bridges at Jackson Water Works and upstream of U.S. Highway 80 also constrict flows to some extent (USGS 1982).

A number of private levees and other flood control structures have also been constructed to protect individual buildings. In addition, filling of the floodplain to raise structures above the 100-year flood elevation has occurred and is continuing. A limited number of buildings have been raised with pilings instead of fill material.

Two former landfills (Gallatin Street and Jefferson Street) and the former Gulf States Creosote plant are also located within the proposed project area. The Gallatin Street landfill extends into the floodplain and restricts flow and is surrounded by the river on three sides.

Downstream of the project area, the Pearl River flows through two Mississippi cities (Columbia and Monticello) and other smaller towns but mostly rural areas with between 76 and 90 percent of the land in counties adjacent to the river being forested (Oswalt 2013). There are many tributaries to the Pearl River south of the project area, but the two largest tributaries occur in the middle portion of the watershed. The Strong River (located at approximately RM 227) flows into the Pearl River just south of Georgetown, and Silver Creek (located at approximately RM 186) joins with the Pearl just south of Monticello. The Bogue Chitto River, located at approximately RM 37, is the largest tributary in the lower Pearl River watershed. Its confluence with the Pearl River is south of Sun, Louisiana, and it drains approximately 1,210 square miles (Forbes 1980). South of Columbia, Mississippi, the flood plain of the Pearl River widens with a corresponding increase in adjacent forested wetlands.

The lower portion of the Pearl River watershed has experienced more land conversion than the middle portion but less than around Jackson with counties along the Pearl River having between 51 and 75 percent forestlands (Oswalt 2013). In the lower watershed, the Pearl River has been altered by the construction of two navigation channels, the Pearl River Navigation Channel and the West Pearl River Navigation Channel. The West Pearl River Navigation Channel includes three navigation locks in the channel and three sills (i.e., weirs approximately 12 feet in height). The sills are located on the Bogue Chitto River, the Pearl River at Pools Bluff, and one near the southern navigation lock. The Pearl River Navigation Project resulted in the snagging and clearing of the river between Bogalusa, Louisiana, and Columbia, Mississippi. Sand and gravel mines are found throughout this area. Downstream from approximately the latitude of Bogalusa, Louisiana, the Pearl River becomes a braided river system with numerous bifurcations. At the distal end of those channels, the swamps give way to tidally influenced marshes. The marshes change in salinity from fresh marshes at the inland areas to more saline marshes near the Gulf coast. The freshwater discharge from the Pearl River typically maintains a large area of lower salinity marshes with more salt-tolerant marshes occurring as a fringe along the Gulf coastline.

Hydrology

The Ross Barnett Reservoir was constructed in 1961 and was filled by 1965. The resulting lake averages 12 feet in depth with a maximum depth of approximately 49 feet. The retention time of the reservoir is 49 days (EPA 1975). Operationally, the Ross Barnett Reservoir must maintain a minimum flow of 112 million gallons of water per day or approximately 170 cubic feet per second (cfs). This discharge rate is greater than low-flow discharge rates experienced preconstruction. The lake is eutrophic with low dissolved oxygen (DO) levels documented in the summer months (EPA 1975; Phalen et al. 1988). In 2013, the PRVWSD increased the Ross Barnett Reservoir winter (October 15 to April 10) pool elevation from 296 feet above sea level to 297 in order to increase the chances of achieving the summer pool elevation of 297.5 because in some summers the pool elevation was not reached. The operational target for the reservoir is 6 inches on either side of the pool elevations. According to the PRVWSD, this increase in water storage should not impact the ability of the reservoir to help manage high-water events (McDowell 2013).

Prior to and after construction of the Ross Barnett Reservoir, Pearl River flows varied primarily in response to rainfall in the basin (Hasse 2006). Groundwater discharge into some of the tributary streams also contributes to flows (Lang 1972; Lee 1985). The bed and banks of the river are primarily comprised of silts, sands, sandstone, and clays, including marl, with gravel deposits also present (Monroe 1954). Some limestone outcroppings occur along the banks as well (Crider 1906). Weathering of the clays can reduce their cohesiveness allowing the Pearl River to meander naturally in the floodplain, with five oxbow lakes being created between 1821 and 1931 near Jackson (Monroe 1954). The floodplain averages three miles in width. Tributary stream floodplains vary in width from two miles for larger tributaries (e.g., Bogue Chitto) to only a few hundred feet for the smallest tributaries. Natural levees that form during floods parallel the river and its larger tributaries and can be up to five feet higher than the adjacent floodplain. Overall the Pearl River Basin has a gentle slope (i.e., gradient) with that of the tributary streams towards the river being less than approximately 10 feet per mile except near the headwaters where it is greater. The downstream slope of the Pearl River is approximately one foot per mile with the floodplain sloping at approximately less than two feet per mile (Monroe 1954; Wilson and Landers 1991).

An analysis of data from four stream gauge stations (Edinburg, Jackson, and Monticello, Mississippi, and Bogalusa, Louisiana) on the Pearl River for pre- (up to 1960) and post-Ross Barnett Dam and Reservoir construction (1964 – 2005) revealed that the same magnitude flood and low-flow events are recurring at greater magnitudes post-construction (Hasse 2006). The analysis indicated that the increase in magnitude of post-construction low flows is an effect of the reservoir. Also revealed was an increase in the median annual rainfall amounts in the upper and middle basin, which has resulted in an increase in the flows for the lower basin. Hasse (2006) also used the *Use of the Indicators of Hydrologic Alteration* software that examined 33 primary and 44 secondary parameters to provide a statistical analysis of changes in stream flows due to landscape changes and/or water resource projects. The greatest hydrologic alteration was observed at the Jackson station immediately downstream of the dam, with the degree of alteration decreasing in a downstream direction. However, hydrologic alteration was also detected at the Edinburg station upstream of the reservoir indicating that landscape and weather pattern changes are partially responsible for some of the alterations within the basin. It was estimated that approximately one-third of the alterations at the Jackson station and one-half at the Bogalusa station were related to landscape and weather pattern changes while the remaining were attributed to the reservoir. The parameters that showed the greatest alteration downstream of the reservoir include the median monthly flows for October, November, and December; the magnitudes of the various annual minimum low flows; the number of low-flow pulses; the annual mean hydrograph rise rate, and the annual number of hydrograph reversals. More specifically, the Jackson and Monticello stations showed an increase in the number of low-flow pulses but a decrease in the low-flow duration; the same changes were observed for the high-pulse events as well. For the Bogalusa station the annual median number of low-flow pulses decreased post-reservoir but the annual duration of low-flow pulses increased; a similar trend for high flow events was also noted. The increase in the hydrograph rise and fall rates post-reservoir construction and the increase in hydrograph reversals are typically associated with flow alterations from dams (Hasse 2006).

Tipton et al. (2004) conducted a geomorphology investigation of the middle portion of the Pearl River between its confluence with the Strong River and Monticello, Mississippi. They examined sand bar stability between 1986 and 1999 and related it to the abundance of darters. Areas experiencing greater instability were found in the lower part of their study area and those areas had fewer darters. Kennedy and Hasse (2009) also conducted a geomorphology study of the entire basin below the Ross Barnett Reservoir. Their study was multi-facetted and reported that the Ross Barnett Reservoir almost entirely removed the upper one-third of the drainage basin from contributing sediment, which has resulted in the incision and degradation of the Pearl and Strong rivers. According to their study, during flood stages, the floodplain captures large quantities of suspended sediments, especially below the confluence with the Strong River. The upper Pearl River (but below the Ross Barnette Dam) is also a major contributor to sediment loads due to the instability of the river and the resulting bank erosion. Instability of the river decreases downstream but is still an important source of excess sediment. The pool created by Pools Bluff Sill acts to stabilize the channel and bank conditions in that area of the lower Pearl River. Downstream of that sill there is an increase in channel stability with most of the instability being primarily related to sand and gravel mining, but also to the navigation channel. Kennedy and Hass (2009) compared their analysis to Tipton et al. (2004) and asserted that the area of instability identified by Tipton et al. (2004) may be migrating downstream. Piller et al. (2004) reported that the Pearl River south of its confluence with the Strong River had undergone a dramatic change, with gravel substrates being replaced with unstable sand substrate following construction of the reservoir.

Conversely, the examination of data from three gauges from within and downstream of the project area (i.e., Jackson, Byram, and Rockport) was performed during the feasibility study by contractors for the FDCD to determine possible changes in discharge and stage (i.e., water level or gauge height) relationship to determine if the Pearl River had undergone any channel changes. Based on that examination it was concluded that the construction of the reservoir, land use changes, urbanization, and channel improvement could have resulted in some instability but has since re-stabilized and remained in a state of dynamic equilibrium. The Jackson gauge used in the analysis is located approximately 1.3 miles upstream of the proposed weir (i.e., within the project area), while the Byram and Rockport gauges are located approximately 14 and 40 miles downstream of the proposed weir, respectively. Because stage-discharge measurements are not taken continually the data represents periodic measurements over the years. Data from the Jackson gauge included the years from 1929-1972, 1973-1977, 1978-1989, and 1990-2010. The Byram gauge included data from only 1984 to 1993 while the Rockport gauge had data from 1940-1949, 1984-1991, and 1992-2010. Based on the examination of that data the stage-discharge relationship was determined to be stable for the Jackson and Byram gauges (Graphs 1 and 2). For the Rockport gauge (Graph 3) there was a slight lowering of the stages (generally less than a foot) for discharges between 32,000 and 51,000 cfs for the time period between the 1940's and 1980's and there was also a possible lowering of the stages for flows less than 4,000 cfs between the 1984-1991 and the 1992-2010 period. The Rockport gauge is located in the same reach of the river where Tipton et al. (2004) and Piller et al. (2004) reported some instability during the later time period.

For the USACE 1996 Draft Environmental Impact Statement (EIS) and Feasibility Study an examination of the river was also undertaken. That examination determined that the upper reach extending 10 miles downstream of the reservoir consisted of mostly fine to medium sands and near vertical banks that are eroding resulting in a major source of sediment to the system. The middle reach (next six miles) consists of the reach altered by previous flood control projects and that reach appeared to be stable but with some signs of degradation. The lower reach (next 15 miles) consisted of a meandering channel with areas of aggradation and degradation. It was noted that the reservoir has reduced the sediment discharge downstream of the dam with some channel degradation, but no significant instability has occurred.

In addition, the contractors for the FDCD examined Google Earth imagery from 1996-2010 to assist in determining bank erosion. For the 16-mile-long project area, eight areas of erosion were identified with six of the sites occurring between the reservoir and Highway 25, just north of the proposed pool; the remaining sites were downstream. That examination determined that 6.5 percent of the study area was experiencing low to moderate meander migration and no significant channel changes were seen. Examination of river banks were also conducted, and based on that examination it was determined that the project area is relatively stable with localized erosion and that the channel may have experienced some degradation in the past, but there was no indication of instability based on limited field observation.

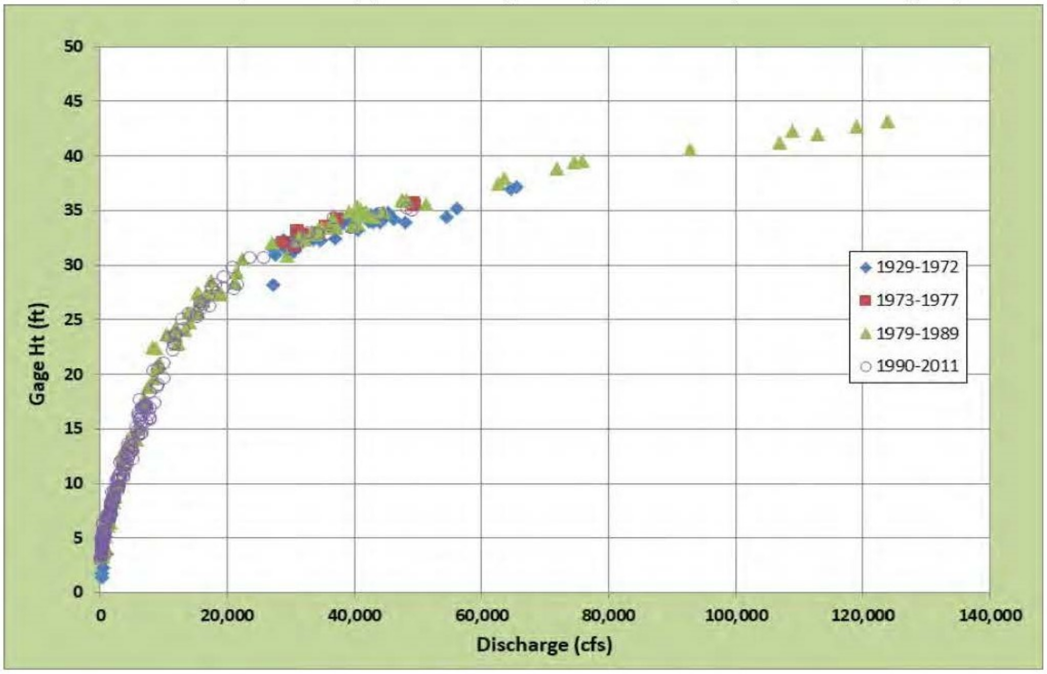
Hydrologic modeling of the project area indicated that the range of velocities within the river varied with the cross-section of the river and floodplain and the river's discharge (Graph 4). Average cross-sectional velocities varied from approximately 0.27 feet per second (fps) to 2.2 fps.

Average monthly discharge, along with the standard deviation and minimum monthly discharge from 1966 to 2013, are presented in Table 1. Typically, June through October have the lowest discharge while December through April have the highest discharge. May and November have discharges that transition between the high and low periods. The percentages of months having discharges less than 1,000, 2,000, 5,000, 10,000, 20,000 and 40,000 cubic feet per second (cfs) are presented in Table 2. In general, discharges greater than 5,000 cfs do not occur between June and November. Discharges greater than 20,000 cfs occur infrequently between December and

May; that is most discharge rates are less than 20,000 cfs during that time period.

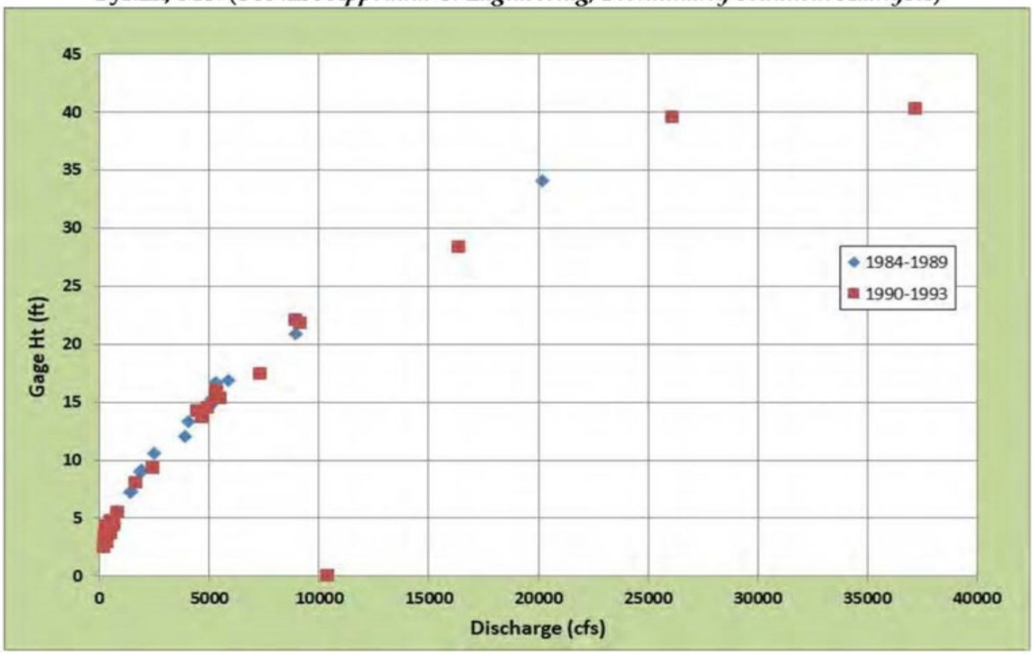
Graph 1.

Exhibit A.1: Stage-discharge relationships for four (4) time periods for the Pearl River at Jackson, MS. (See also *Appendix C: Engineering, Preliminary Sediment Analysis*)



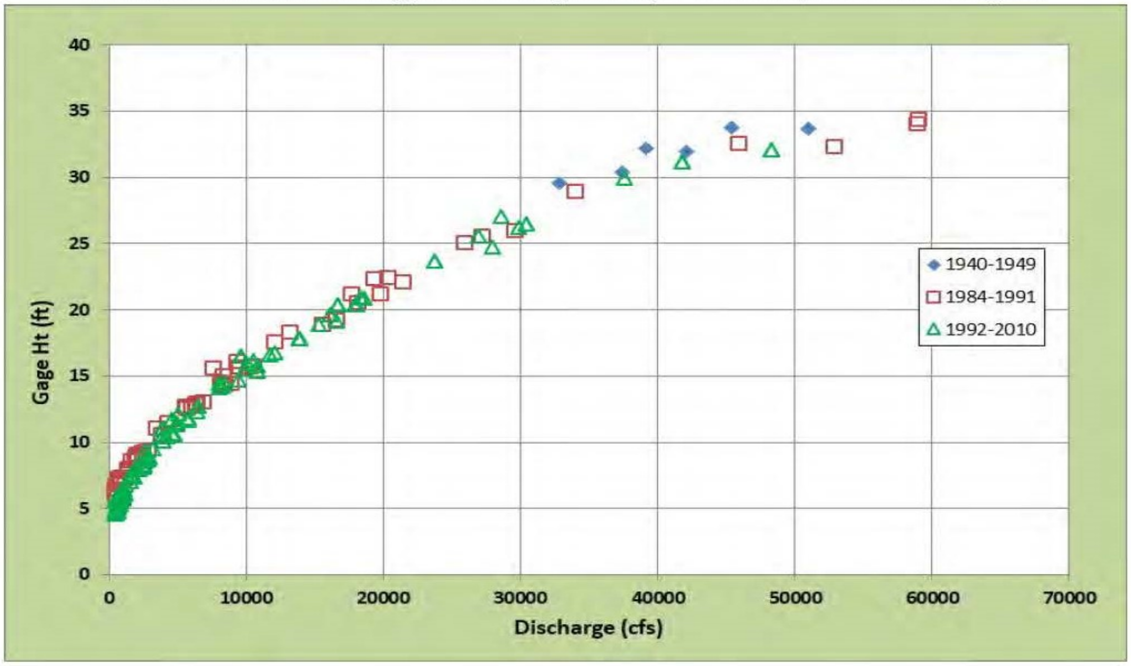
Graph 2.

Exhibit A.2: Stage-discharge relationships for two (2) time periods for the Pearl River at Byram, MS. (See also *Appendix C: Engineering, Preliminary Sediment Analysis*)



Graph 3.

Exhibit A.3: Stage-discharge relationships for four time periods for the Pearl River at Rockport, MS. (See also *Appendix C: Engineering, Preliminary Sediment Analysis*)



Graph 4. Velocities in the Action Area. Green shade represents area north of the pool.

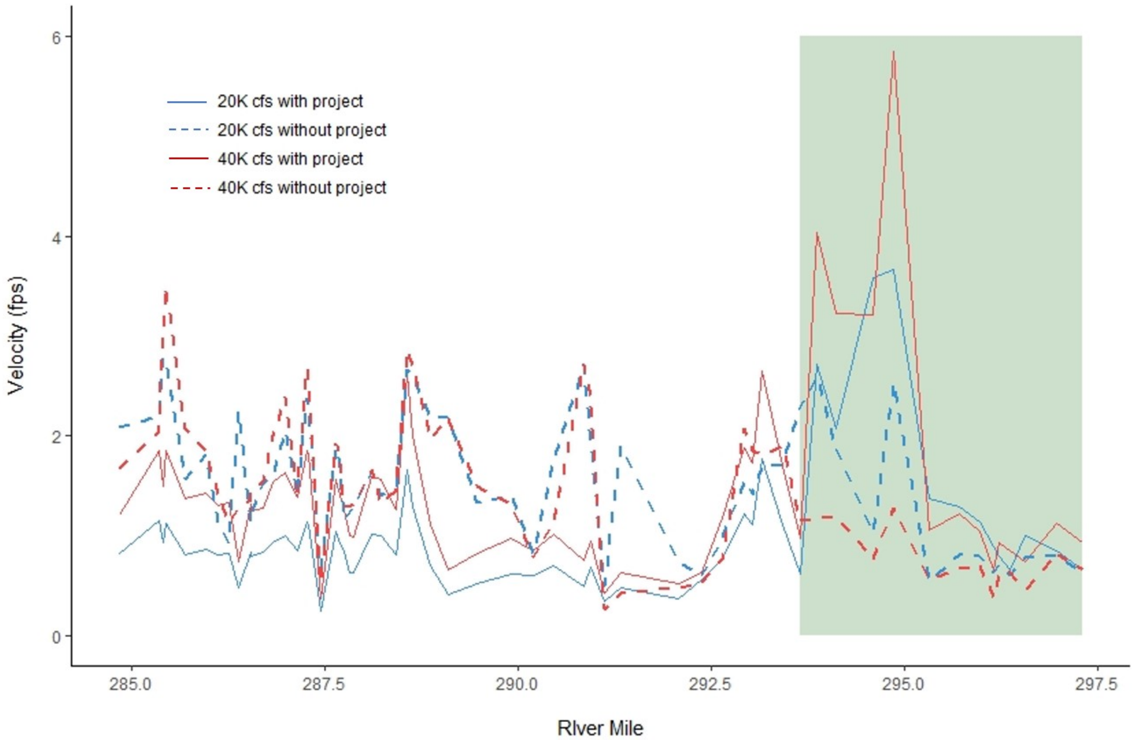


Table 1. Monthly average discharge (cfs), 1 Standard Deviation (STD) and minimum monthly average flow 1966-2013.

	Jan	Feb	March	April	May	June	July	August	Sept	Oct	Nov	Dec
Average	8333	9303	9101	8183	4312	1562	1154	961	1140	1331	2078	5421
1 STD	5920	5875	4914	7700	4816	1734	1330	1237	1683	2313	1967	4868
Minimum	338	321	1233	412	256	183	180	197	208	195	142	298

Table 2. Percent of months having discharge less than the rate indicated from 1966-2013.

Discharge cfs	Jan	Feb	March	April	May	June	July	August	Sept	Oct	Nov	Dec
<1000	8	2	0	8	23	52	65	65	75	77	43	11
<2000	15	4	6	21	42	81	85	92	85	85	57	26
<5000	31	29	21	42	67	92	96	98	96	94	89	57
<10,000	71	56	65	71	92	100	100	100	100	98	100	87
<20,000	96	96	96	92	98	100	100	100	100	100	100	98
<40,000	100	100	100	100	100	100	100	100	100	100	100	100

Overall the Pear River Basin has undergone alterations due to changes in the landscape (e.g., land clearing, navigation, flood control) that impact the ecological functions of the area. These ongoing impacts have led to the reduction and/or loss of habitat which has resulted in the listing of species under the ESA. Declines in other species endemic to the Pearl River Basin because of the ongoing alterations may result in the additional listing of other species. A comprehensive watershed assessment should be undertaken to identify pro-active measures that would ensure the protection of fish and wildlife values in the basin while achieving socio-economic needs.

PREVIOUS FLOOD CONTROL INVESTIGATIONS

Floods are natural events that occur when a river, like the Pearl River, is required to carry more water than can be contained within its banks. The frequency and degree of flooding is related to area, topography, rainfall, soils, and the physical conditions of both the floodplain and surrounding uplands. Therefore, at any point in time, the Pearl River is simply responding to the rigid, yet dynamic set of natural "rules" that determine the nature of its course and capacity.

Like many river systems, the Pearl River system is sensitive to changes in the parameters described above. Early and ongoing timber practices, upstream and tributary drainage improvements, and development and encroachment into the floodplain have resulted in the placement of man's activities directly in the path of potential floods, which can cause a river to flood to a greater degree than it did historically. Consequently, property damages from floods are the direct outcome of the above situations. These tragic consequences will continue to occur as long as clearing, developing, and occupation of the floodplain continue. It is evident that nature is responsible for floods while man is responsible for flood damages.

Floodplain development at Jackson has generally entailed the loss of existing natural vegetation, which, in turn, causes a severe reduction of associated fish and wildlife populations. Altered river systems like the Pearl River system often have a diminished ability to retard flood flows, absorb pollutants, anchor soils, reduce sediment loads, and provide rich recreational and aesthetic resources. The consequences of unregulated encroachment and alteration of the Pearl River floodplain at Jackson are evident.

Efforts to address flooding due to floodplain development started years ago and were contained in the Flood Control Act of June 22, 1936. However, city officials declined to provide both the necessary rights-of-way and the required agreement to maintain the project, resulting in the project’s deauthorization.

Flood control investigations were again authorized by the River and Harbor Act of 1945 and the Flood Control Act of 1946 (Public Law 526), which resulted in the June 30, 1959, Survey Report of the Mobile District. The District Engineer recommended the construction of what today are known as the Jackson and East Jackson Levees, with pumping plants to relieve interior ponding and to promote floodplain development; those levees were completed in 1968.

In the 1970 Pearl River Basin Comprehensive study the USACE sought Congressional authorization for the design and construction for three dams and reservoirs which were to be located upstream of the Ross Barnett Reservoir. Subsequently, Congress authorized the Edinburg Dam and Reservoir and post-authorization design studies were initiated; however, those studies determined that the structure was economically infeasible and it was not constructed.

In April 1979, a storm with an estimated 500-year exceedance frequency dropped nearly 20 inches of rain in the upper Pearl River Basin in less than two days, precipitating the greatest flood ever recorded on the river (i.e., the Easter Flood). Floodwaters crested at 15 feet above flood stage on April 17, 1979, causing widespread devastation with damage estimates of up to $200,000,000 at Jackson (USACE 1981). Floodplain development was responsible for much of this damage. The East Jackson levee was almost overtopped while the Jackson levee was flanked during the flood. The levees also constituted an artificial constriction of the floodplain, which caused a significant increase in flood stages upstream and a corresponding increase in subsequent damages.

Even with the floodwater retarding effect of Highway 43, as previously mentioned, the Ross Barnett Dam had to release 125,000 cfs to keep from being overtopped. Although this rate of release attenuated the upstream flood from the 500-year event down to the 200-year event at Jackson, the potential for dam failure was very real since the Ross Barnett project was never designed or built for flood control purposes but for water supply and recreation. Numerous other human encroachments into the floodplain, including residential development, inadequately designed roads and bridges, a sanitary landfill, and the city's sewage treatment plant, were damaged by the flood and contributed to its severity. The flood of 1979 was a natural event, which only magnified and accentuated the consequences of development and changes of the Pearl River floodplain, which had occurred over the previous years.

Following that flood, several Congressional resolutions directed the USACE to begin intensive planning to provide flood relief for Jackson as part of its ongoing basin-wide comprehensive water resource development study. In 1981, the USACE identified four flood control measures. Two of those measures, a cleared floodway through Jackson and a "dry" reservoir upstream of the Ross Barnett Reservoir, known as Shoccoe Dam, were considered in detail.

In Fiscal Year 1983, Congress authorized the Four-Point Plan whose primary component was clearing within the floodway. The Service prepared a FWCA report (Service 1985) to accompany the USACE Feasibility Report and Environmental Impact Statement (USACE 1984, revised 1985). These reports evaluated additional clearing of vegetation within the floodway and the Shoccoe Dam and Dry Reservoir. Congress authorized construction of the Shoccoe Dam and associated project features in the Water Resources Development Act of 1986 (Public Law 99-662.). The clearing feature was constructed in 1984; however, the Shoccoe Dam was not constructed due to the lack of a local interest.

In 1996, the USACE examined the feasibility of constructing levees along both sides of the Pearl River to provide flood control to the greater Jackson area (Jackson Metro Flood Control Study). That study examined the same flooding problems the currently proposed plan is now addressing; however, again no local sponsor agreed to cost-share project implementation. Subsequently, a two-lake plan was also investigated but was determined to not be feasible.

FISH AND AQUATIC RESOURCES

Fishery habitat within the study area includes the Pearl River main stem and tributaries, the Ross Barnett Reservoir, a number of oxbow lakes such as Mayes Lake, channel cutoffs such as Crystal Lake, and several other smaller lakes or ponds. In addition, many of the oxbow lakes and sloughs are associated with forested wetlands ecosystems dominated by hardwoods interspersed with cypress-tupelo brakes. This forested wetland complex, in association with the river and its diverse habitats, provides ideal habitat for many fish and wildlife species, resulting in a high species diversity.

Water quality in the Pearl River main stem as well as its tributaries varies with some urban tributaries not meeting all water quality standards. The most frequently mentioned reasons for impairment in the Pearl River and tributaries include organic enrichment, low DO, and sediment. Sediment impairment is related to non-point source issues, possibly an indication of the instability of the banks and/or surrounding land uses. Water quality in the project area is reduced due to the influence of the city. However, water quality can recover somewhat downstream of those influences. The set minimum discharge for the reservoir is approximately 170 cfs; however, downstream discharge of the Savanna Street Wastewater Treatment Facility is based on a critical low flow of 227 cfs. Between those locations there are several tributary streams that contribute flow to the river. During droughts, the minimal discharge from the reservoir at times could be below that required for adequate dilution and flushing of the wastewater facility's discharges.

The Pearl River and associated water bodies within this portion of the basin support a diverse fishery. There are 116 freshwater fish species known to occur in the Pearl River Basin (Service 1981). Species present include largemouth and spotted bass; bluegill, long-ear, green, and red-ear sunfish; crappie; catfishes; and the American eel. The MDWFP have stocked hybrid striped bass, an important sport fish, in the Ross Barnett Reservoir, and significant numbers of hybrid striped bass are caught in the area immediately downstream of the reservoir. Many species of minnows and darters use the varied habitats of the Pearl River Basin and serve as ready food sources for other species.

The fishery resources of the Pearl River and Ross Barnett Reservoir, as well as those of Mayes Lake (located north of the ICG railroad bridge at RM 290.58) and Crystal Lake (located north of U.S. Highway 80), are heavily used by sport fishermen. The high quality of those resources and their proximity to a major metropolitan area make them especially valuable.

The Pearl River hosts numerous mussels that prefer firm and stable substrate with various sediment types primarily in locations where mussels can embed without being dislodged by river currents such as below sand bars and along flats/bottoms of river channels. There is a known mussel bed located just north of Lowhead Dam, where firm silty/sandy beds provide suitable habitat for numerous mussel species. The bed has a diverse compliment of mussels totaling nearly 20 species including several rare species (Weiland 2000).

The Pearl River and West Pearl River Navigation channels have altered the lower Pearl River Basin. The West Pearl River project was constructed in 1953, but it is no longer maintained.

The project included a dredged channel 7 feet deep and 100 feet wide, three locks, and three sills. The sills are located at the upstream end of the navigation channel in the Pearl River (Pool's Bluff Sill), at the navigation channel's intersection with the Bogue Chitto River (Bogue Chitto Sill), and near the southern most lock (Talisheek Sill). The Pearl River Navigation Project was completed in 1970 and included the snagging and clearing of a 65-mile-long and 150-foot-wide channel from Bogalusa, Louisiana, to Columbia, Mississippi.

In the southern portion of the Pearl River Basin, coastal wetlands also provide nursery and foraging habitat that supports economically important marine fishery species such as spotted seatrout, sand seatrout, southern flounder, Atlantic croaker, spot, Gulf menhaden, striped mullet, white mullet, blue crab, and brown and white shrimp. Some of these species serve as prey for other commercially and/or recreationally important fish species.

TERRESTRIAL AND WILDLIFE RESOURCES

Wildlife habitat quality within the study area is varied but some areas still provide higher quality habitat. This is particularly noteworthy considering the proximity to Jackson. More productive wildlife habitats include the wetland areas vegetated with bottomland hardwoods and the cypress-tupelo areas associated with Mayes Lake, the Fannye Cook Natural Area, and Crystal Lake (Pearl River Cutoff). Forested wetland areas vegetated with bald cypress, tupelo gum, red maple, water oak, willow oak, American elm, swamp hickory, green ash, sycamore, and black willow are found along both sides of the Pearl River throughout the study area, except for the cleared portions. These wetlands provide habitat for wildlife as well as contribute to aquatic species production. Of the 490 vertebrate wildlife species occurring within the Pearl River Basin, a higher percentage use bottomland hardwoods as primary habitat (habitat on which a species depends for reproduction and/or feeding during all or a portion of the year) than any other habitat type. The forested floodplain provides low to high quality habitat for deer, squirrel, wood duck, migratory waterfowl, furbearers, neotropical migratory birds, and a number of other game and nongame species (Service 1981). Esthetically, riparian areas provide green space in an urban landscape.

The existing flood control project in the project area has significantly modified floodplain habitats; the project consists of two earthen levees on either side of the river totaling 13.2 miles. There is also channel work associated with the levees which includes 9.3 miles of enlargement and realignment of the main river channel through the town of Jackson (approximately 5 miles of cutoffs). Maintenance includes any necessary periodic removal of vegetation along a 650-foot-wide cleared strip of floodplain along the river and complete clearing downstream of that; a total of 346 acres of the floodplain (approximately 40 percent of the riparian area) is maintained in some form of cleared or partially cleared floodplain. These flood control features fragment and reduce the value of floodplain habitat within those areas. Remaining areas outside of the project area provide a higher quality of habitat as described below.

Forested buffers along waterways (i.e., riparian habitat) provide unique values as an ecologically functional unit. The riparian zone provides all the values to fish and wildlife resources that bottomland hardwoods and bald cypress swamps provide, as well as values that are intrinsic to riparian areas. Riparian zones within the floodplain are important in maintaining gene flow between wildlife populations because animals moving between forested tracts use them as corridors. Many small animals, including small mammals, reptiles, and amphibians are restricted to riparian habitat and many, if not most, large animals such as white-tailed deer require access to streams or lakes for survival even though they spend most of their time elsewhere (Odum 1978). Because of the abundance of insects, open areas for feeding, and the fact that riparian areas often provide the only woody cover within cleared and developed landscapes, forested riparian habitat provides important feeding and nesting areas for numerous songbirds (Stauffer and Best 1980). Riverfront habitats, particularly cottonwood/black willow/river birch forests, have been determined to be vulnerable because of altered hydrology, stream channel modification, and streambed destabilization (MDWFP 2016).

The riparian zone also provides important breeding and wintering habitats for a variety of migratory birds such as white-eyed vireo, yellow-billed cuckoo, prothonotary warbler, Northern parula, and redheaded woodpecker. Those non-game species have exhibited substantial population declines over the last 30 years, primarily as the result of habitat loss and fragmentation. Wood ducks also nest in riparian zones, and use flooded swamps and the vegetated portions of channels for brood-rearing habitat.

Overflow areas within the riparian zone are optimal fish spawning and nursery grounds because of the cover provided by slack water, debris, and vegetation, and the abundance of food provided in the nutrient-rich floodwaters. Riparian habitats also contribute vital elements to fishery resources in the form of detritus, shade, and in-stream cover.

Klimas (1987) determined that a 300-foot-wide forest buffer would sufficiently reduce floodwater velocities to protect adjacent levees from erosive water flows. Dwyer et al. (1997) reported that a 300-foot-wide forested corridor between the Missouri River and the adjacent levees reduced the chance of levee failure during flood events. Allen et al. (2003) determined that during the 1993 flood 83 percent of levee failures occurred where the forest corridor was less than 500-feet-wide and that the median length of levee failures was significantly wider along the riverbanks that had no forested corridor. Geyer et al. (2000) concluded that forested buffers along the Kansas River were highly beneficial in protecting the riverbank from erosion during that same flood. The U.S. Army Corps of Engineers' Engineers Manual (EM) 1110-2-1913 Section 7-6(3) Protection of Riverside Slopes states, "The riverside slope may be shielded from severe wave attack and currents by timber stands and wide space between the riverbank and the levee." A forested buffer can reduce the need for structural levee slope protection and is consistent with Implementation Guidance for Section 1184 of the Water Resources Development Act of 2016.

Sandbars in various stages of development are also typical features of the Pearl River in the study area. Those sedimentation features tend to concentrate high numbers of small fishes in both lake and flowing water environments (Baker et al. 1991). Sandbars within lakes are more ephemeral than those in flowing waters due to fluctuating water levels, although both types may be inundated at high river stages. Sandbars and exposed mudflats along the river and oxbow lakes also provide valuable habitat for various species of shorebirds, terns, wading birds, and turtles. Weiland (2000) identified sand bars as an imperiled habitat due to their rarity and other factors that increased their vulnerability to statewide degradation. That habitat was also given this rank because of its use as nesting habitat by federally listed species and/or at-risk species.

Mammals known to occur in the project area and the Pearl River Basin's forested wetlands and marsh habitats include mink, raccoon, swamp rabbit, nutria, river otter, and muskrat. Those habitats also support a variety of birds including herons, egrets, ibises, rails, gallinules, neotropic cormorant, white pelican, black-necked stilt, sandpipers, gulls, and terns.

In addition to bottomland hardwood habitat, smaller areas of upland hardwoods, mixed hardwood-pine woodlands, pasture, and cropland are present in the study area (Table 1) (USACE 1994). Those habitat types also support a number of game and nongame wildlife populations. Hunting is prohibited in many areas due to the proximity of urban development. Where hunting is permitted, the resources are heavily used.

Scrub-shrub 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, scrub-shrub habitat is bordered by marsh or open water at lower elevations and by developed areas, cypress-tupelo swamp, or bottomland hardwoods at higher elevations. Typical scrub-shrub vegetation includes elderberry, wax myrtle, buttonbush, black willow, Drummond red maple, Chinese tallow-tree, and groundsel bush. Some scrub-shrub habitat is an early successional stage of bottomland hardwood forests.

FEDERALLY LISTED SPECIES

The northern long-eared bat (*Myotis septentrionalis*), federally listed as a threatened species, is a medium sized bat about 3 to 3.7 inches in length and is distinguished by its long ears. Its fur color can range from medium to dark brown. The northern long-eared bat can be found in much of the eastern and north central United States. Northern long-eared bats occur in mixed pine/hardwood forest with intermittent streams. Northern long-eared bats roost alone or in small colonies underneath bark or in cavities or crevices of both live trees and snags (dead trees). During the winter, northern long-eared bats often hibernate in caves and abandoned mines. Northern long-eared bats emerge at dusk to fly through the understory of forested hillsides and ridges to feed on moths, flies, leafhoppers, caddis flies, and beetles, which they catch using echolocation. This bat can also feed by gleaning motionless insects from vegetation and water surfaces. The most prominent threat to this species is white-nose syndrome, a disease known to cause high mortality in bats that hibernate in caves. Other sources of mortality for northern long-eared bats are wind energy development, habitat destruction or disturbance, climate change, and contaminants.

The threatened wood stork (*Mycteria americana*) is a large, long-legged wading bird, about 50 inches tall, with a wingspan of 60-65 inches. The plumage is white except for black primary feathers and secondary feathers and a short black tail. The head and neck are largely unfeathered and dark gray in color. Two distinct populations of wood storks occur in the United States. One population breeds in Florida, Georgia, and South Carolina, and is federally protected (threatened). The other population breeds from Mexico to northern Argentina and is not federally protected under the Endangered Species Act (ESA) of 1973 (87 Stat. 884, as amended;

16 U.S.C. 1531 et seq.). Wood storks from each of these populations occur seasonally in Mississippi during the non-breeding season (May-October) and are not distinguishable from one another. The major threat to this species is a reduction in food base (primarily small fish) due to habitat loss, modification, and fragmentation. Typical foraging sites include freshwater marshes, swales, ponds, hardwood and cypress swamps, narrow tidal creeks, shallow tidal pools, and artificial wetlands (such as stock ponds; shallow, seasonally flooded roadside or agricultural ditches; and impoundments). Suitable habitat for this species occurs within the project area.

The threatened ringed map (formerly known as the sawback) turtle (*Graptemys oculifera*) is endemic to the Pearl River system. This turtle prefers riverine habitats with moderate currents; channels wide enough to permit sunlight penetration for several hours each day; numerous logs for basking; and large, sandy banks used for nesting. The ringed map turtle is a small turtle (4 to 7 inches in plastron length) with a yellow ring bordered inside and outside with dark olive-brown on each shield of the carapace and a yellow plastron. The head has a large yellow spot behind the eye, two yellow stripes from the orbit backwards, and a characteristic yellow stripe covering the whole lower jaw. The decline of the ringed map turtle has been attributed to habitat modification (i.e., loss of exposed sandbars, basking areas) and water quality deterioration, reservoir construction, channelization, desnagging for navigation, siltation, and the subsequent loss of invertebrate food sources.

The threatened Atlantic or Gulf sturgeon (*Acipenser oxyrhynchus desotoi*) is an anadromous fish that occurs in many rivers, streams, and estuarine and marine waters along the northern Gulf coast between the Mississippi River and the Suwannee River, Florida. In Louisiana, Atlantic sturgeon have been reported at Rigolets Pass, rivers and lakes of the Lake Pontchartrain Basin, the Pearl River System, and adjacent estuarine and marine areas. Spawning occurs in coastal rivers between late winter and early spring (i.e., March to May). Adults and sub-adults may be found in those rivers and streams until November, and in estuarine or marine waters during the remainder of the year. Atlantic sturgeon less than two years old appear to remain in riverine habitats and estuarine areas throughout the year, rather than migrate to marine waters. Habitat alterations such as those caused by water control structures and navigation projects that limit and prevent spawning, poor water quality, and over-fishing have negatively affected this species.

On March 19, 2003, the Service and the National Marine Fisheries Service (NMFS) published a final rule in the Federal Register (Volume 68, No. 53) designating critical habitat for the Atlantic sturgeon in Louisiana, Mississippi, Alabama, and Florida. The proposed project area is located in critical habitat Unit 1, which includes “the Pearl River main stem from the spillway of the Ross Barnett Dam, Hinds and Rankin Counties, Mississippi, downstream to where the main stem river drainage discharges at its mouth joining Lake Borgne, Little Lake, or The Rigolets in Hancock County, Mississippi, and St. Tammany Parish, Louisiana. It includes the main stems of the East Pearl River, West Pearl River, West Middle River, Holmes Bayou, Wilson Slough, downstream to where these main stem river drainages discharge at the mouths of Lake Borgne, Little Lake, or the Rigolets. Unit 1 also includes the Bogue Chitto River main stem, a tributary of the Pearl River, from Mississippi State Highway 570, Pike County, Mississippi, downstream to its confluence with the West Pearl River, St. Tammany Parish, Louisiana. The lateral extent of Unit 1 is the ordinary high water line on each bank of the associated rivers and shorelines” (Federal Register Volume 68, No. 53, p. 13391). The primary constituent elements essential for the conservation of Gulf sturgeon, which should be considered when determining potential project impacts, are those habitat components that support feeding, resting, sheltering, reproduction, migration, and physical features necessary for maintaining the natural processes that support those habitat components. The primary constituent elements for Atlantic sturgeon critical habitat include:

- abundant prey items within riverine habitats for larval and juvenile life stages, and within estuarine and marine habitats for juvenile, sub-adult, and adult life stages;

- riverine spawning sites with substrates suitable for egg deposition and development, such as limestone outcrops and cut limestone banks, bedrock, large gravel or cobble beds, marl, soapstone, or hard clay;

- riverine aggregation areas, also referred to as resting, holding and staging areas, used by adult, sub-adult, and/or juveniles, generally, but not always, located in holes below normal riverbed depths, believed necessary for minimizing energy expenditures during freshwater residency and possibly for osmoregulatory functions;

- a flow regime (i.e., the magnitude, frequency, duration, seasonality, and rate-of-change of freshwater discharge over time) necessary for normal behavior, growth, and survival of all life stages in the riverine environment, including migration, breeding site selection, courtship, egg fertilization, resting, and staging; and necessary for maintaining spawning sites in suitable condition for egg attachment, egg sheltering, resting, and larvae staging;

- water quality, including temperature, salinity, pH, hardness, turbidity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages;

- sediment quality, including texture and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages; and,

- safe and unobstructed migratory pathways necessary for passage within and between riverine, estuarine, and marine habitats (e.g., a river unobstructed by a permanent structure, or a dammed river that still allows for passage).

Federally listed as a threatened species, the Alabama heelsplitter mussel (*Potamilus inflatus*) was historically found in Louisiana in the Amite, Tangipahoa, and Pearl Rivers. The species presence in the Pearl River is based on two dead specimens reported from the West Pearl River drainage in 1996. This freshwater mussel typically occurs in soft, stable substrates such as sand, mud, silt, and sandy gravel, in slow to moderate currents. Heelsplitter mussels are usually found in depositional pools below sand point bars and in shallow pools between sandbars and riverbanks. Major threats to this species are the loss of habitat resulting from sand and gravel dredging and channel modifications for flood control, as shown by the apparent local extirpation of the species in the extensively modified upper portions of the Amite River.

Additional consultation with the Service is recommended if: 1) the scope or location of the proposed project is changed significantly, 2) new information reveals that the action may affect listed species or designated critical habitat; 3) the action is modified in a manner that causes effects to listed species or designated critical habitat; or 4) a new species is listed or critical habitat designated. Additional consultation as a result of any of the above conditions or for changes not covered in this consultation should occur before changes are made and or finalized.

AT-RISK SPECIES and SPECIES OF CONCERN

The Service's Southeast Region has defined "at-risk species" as those that are:

1. Proposed for listing under the ESA by the Service;
2. Candidates for listing under the ESA, which includes species that have a "warranted but precluded 12-month finding"; or
3. Petitioned for listing under the ESA, which means a citizen or group has requested that the Service add them to the list of protected species. Petitioned species include those for which the Service has made a substantial 90-day finding as well as those that are under review for a 90-day finding. As the Service develops proactive conservation strategies with partners for at-risk species, the states' Species of Greatest Conservation Need (defined as species with low or declining populations) will also be considered.

The Service's goal is to work with private and public entities on proactive conservation to conserve these species thereby precluding the need to federally list as many at-risk species as possible. Discussed below are species currently designated as "at-risk" that may occur within the project area. While not all species identified as at-risk will become ESA listed species, their potentially reduced populations warrant their identification and attention in mitigation planning.

The preferred alternative (Alternative C) could affect six aquatic at-risk species that have been petitioned for listing. Similarly, the States of Mississippi and Louisiana also have lists of Species of Concern (Table 3), for which consideration of potential projects impacts should be addressed. Species of Concern is an informal term that is not defined in any federal conservation legislation. For this report, the term refers to species that are declining or appear to be in need of conservation. It may also include recently delisted species. Also included under the term are species identified in State Wildlife Action Plans and professional society or organization lists (e.g., American Fisheries Society). These lists identify species so that during project planning, conservation measures can be adopted to help ensure the long-term conservation of these species and remove threats that may contribute to the future need to list these species under the Endangered Species Act. In this section we will specifically address those species of concern that have been petitioned for listing.

Table 3. Species of Concern and at-risk species for both Mississippi and Louisiana (including State rankings[1]) that occur within the Pearl River Basin and may be affected by the proposed action.

SPECIES	Mississippi Status[1]	Louisiana Status[1]
BIRDS		
American Swallow-tailed Kite (*Elanoides forticatus*)	--	S1, S2B
Bald Eagle (*Haliaeetus leucocephalus*)	S2	--
Osprey (*Pandion haliaetus*)	S3	S3
REPTILES		
Alligator Snapping Turtle (*Macrochelys temminckii*)[2]	S2	S3
Diamond-backed Terrapin (*Malaclemys terrapin*)	--	S3
Pearl River Map Turtle (*Graptemys pearlensis*)[2]	S2	S3
Rainbow Snake (*Farancia erytrogramma*)	S2	S2
Stripe-necked Musk Turtle (*Sternotherus minor*)	--	S1
AMPHIBIANS		
Mud Salamander (*Pseudotriton montanus*)	S2	S1
FISH		
Alabama Shad (*Alosa alabamae*)	S1	S1
Alligator Gar (*Atractosteus spatula*)	S3	--
Black Buffalo (*Ictiobus niger*)	S3	--
Clear Chub (*Hyhopsis winchelli*)	--	S3
Shoal Chub (*Macrhybopsis tomellerii*)	--	S3
Longjaw Minnow (*Ericymba amplamala*)		
Bluenose Shiner (*Pteronotropis welaka*)	S2	S2
Channel Darter (*Percina copelandi*)	--	S2
Redspot Darter (*Etheostoma artesiae*)	--	S3
Saddleback Darter (*Percina vigil*)	--	S3
Chestnut Lamprey (*Ichthyomyzon castaneus*)	S2	--
Crystal Darter (*Crystallaria asprella*)	S2	S2
Flagfin Shiner (*Pteronotropis signipinnis*)	--	S2
Frecklebelly Madtom (*Noturus munitus*)[2]	S1	S1
Freckled Darter (*Percina lenticula*)	S1	S1
Gulf Logperch (*Percina suttkusi*)	--	S2
Ironcolor Shiner (*Notropis chalybaeus*)	S1	--
Least Killifish (*Heterandria formosa*)	S3	--
Northern Starhead Topminnow (*Fundulus dispar*)	S2	--
Paddlefish (*Polyodon spathula*)	S3	S3
River Redhorse (*Moxostoma carinatum*)	S2	S1

SPECIES	Mississippi Status[1]	Louisiana Status[1]
Southeastern Blue Sucker (*Cycleptus meridionalis*)	S2	S1
Striped Bass (*Morone saxatilis*)	S2	--
CRUSTACEANS		
Flatwoods Digger (*Fallicambarus oryktes*)	--	S2
Pearl Blackwater Crayfish (*Procambarus penni*)	S2	--
Plain Brown Crawfish (*Procambarus shermani*)	--	S2
Ribbon Crayfish/Crawfish (*Procambarus bivittatus*)	S2	S2
MUSSELS		
Alabama Hickorynut (*Obovaria arkansasenis*)[2,3]	S2	--
Alabama Spike (*Elliptio arca*)[2]	S1	--
Black Sandshell (*Ligumia recta*)	S1	S1
Delicate Spike (*Elliptio arctata*)[2]	S1	--
Elephant-ear (*Elliptio crassidens*)	--	S3
Mississippi Pigtoe (*Pleurobema beadleianum*)	S2	S2
Pascagoula creekshell (*Strophitus pascagoulaensis*)[2,4]	--[4]	--[4]
Rock Pocketbook (*Arcidens confragosus*)	S3	--
Southern Hickorynut (*Obovaria jacksoniana*)	S1	S1, S2
Southern Rainbow (*Villosa vibex*)	--	S2
White Heelsplitter (*Lasmigona complanata*)	S3	--

[1]State rankings depicted in this Table are defined as follows: S1 = critical imperiled because of extreme rarity (5 or fewer known extant populations) or because of some factor(s) making it especially vulnerable to extirpation; S2 = imperiled because of rarity (6 to 20 known extant populations) or because of some factor(s) making it especially vulnerable to extirpation; S3 = rare and local throughout the state or found locally in a restricted region of the state, or because of some factor(s) making it especially vulnerable to extirpation (21 to 100 known extant populations); SH = historical occurrence in the state but no recent records verified within the last 20 years, formerly part of the established biota, possibly still persisting; B or N = used as a qualifier of numeric ranks and indicating whether the occurrence is breeding or nonbreeding.
[2]At-risk species.
[3]Formerly *O. unicolor*.
[4] Formerly Rayed Creekshell (*Anodontoides radiatus*); this species has not received an updated S or G ranking at this time but previously it was ranked S1 by both states.

There is one petitioned fish species that occurs in the Pearl River. The frecklebelly madtom is a member of the catfish family, reaching an adult length of 1.4 to 3.5 inches. The species was formerly widely distributed in the Pearl and Mobile drainages of Mississippi, Alabama, Louisiana, and Georgia. The species occurs within the main stem and larger tributaries of the Pearl River south of the Ross Barnett Reservoir. The species prefers stable gravel or rubble riffles and rapids. Its low mobility and low reproductive potential make it extremely sensitive to siltation, sedimentation and disturbance of gravel bars (Endangered Species of Mississippi, MDWFP 2014).

Four petitioned mussel species occur within the Pearl River. The Alabama hickorynut, the Alabama spike, the delicate spike, and the Pascagoula creekshell are generally found on gravel or sand shoals of medium sized creeks to large rivers, and are occasionally found on sand-bottomed runs with slow, steady current. Threats to those species include dams, weirs, channelization, and other stream modification actions, as well as poor water quality and sedimentation. The Alabama hickorynut has been collected between the project area and the Ross Barnett Reservoir and in the lower Pearl. The Alabama spike has also been collected from the lower Pearl River, while the delicate spike has been collected above the Ross Barnett Reservoir and near the Strong River. Because the Alabama spike is found a significant distance downstream the Service does not anticipate that it will be impacted by the project. The Pascagoula creekshell has been collected in tributaries above the Ross Barnett Reservoir and south of the project area.

Two petitioned turtle species occur within the proposed project area, the Pearl River map turtle and the alligator snapping turtle. The Pearl River map turtle is a moderate-sized aquatic turtle endemic to the Pearl River drainage of Louisiana and Mississippi. The species overlaps with the federally listed ringed map turtle and has similar habitat requirements (i.e., flowing streams, nesting sandbars, basking logs, etc.). Historically, the Pearl River map turtle was commonly found in higher abundance than the threatened ringed map turtle; however, the species is now found in lower numbers than the ringed map turtle throughout much of its range (Jones and Selman 2009); including the impact area (Selman 2018). Threats have been attributed to water pollution impacting mollusk populations on which the turtles feed, snag and log removal, channelization and impoundment, collection for the pet trade, increasing nest predation rates, and target shooting (IUCNredlist.org).

The alligator snapping turtle occurs in waterways that drain into the Gulf of Mexico. Although the species range is large, population densities are likely low throughout the range. They occur in various habitats including rivers, oxbows, lakes, and backwater swamps. The main threats include habitat alteration, exploitation by trappers, pollution, and pesticide accumulation (IUCNredlist.org). They have been documented at Crystal Lake and in the southern portion of the Ross Barnett Reservoir (Berry 2019).

Records from the Mississippi heritage program database and other sources indicate six of the seven petitioned species have been collected in or in the vicinity of the project area, however, no biological surveys have been conducted specifically to address whether these petitioned species are found within the project area. If present, these species could be affected by the proposed action.

PUBLIC LANDS AND LANDS HELD FOR CONSERVATION

There are several areas of public lands near the study area. The MDWFP manages the 4,500-acre Pearl River Waterfowl Refuge and Management Area located northwest of the Ross Barnett Reservoir. The MDWFP also manages Mayes Lakes, a 390-acre natural area within the 490-acre

LeFleur's Bluff State Park. That park is located on the northwestern side of the study area, adjacent to the Pearl River, and partially within the floodplain. The National Park Service manages the Natchez Trace Parkway that runs along the west side of the Ross Barnett Reservoir north of the study area before continuing northward. The 2,900-acre Fannye Cook Natural Area is located along the East Bank of the Pearl River from the Ross Barnett Reservoir spillway to Highway 25 (i.e., Lakeland Drive). Those public lands and conservation areas provide opportunities for fishing and non-consumptive uses such as camping, nature photography, bird watching, and hiking to the citizens of the Jackson metropolitan area. The Pearl River Management Area also allows public hunting for selected game species.

Outside of the immediate project area and downstream there are several water parks providing access to the river and opportunities for fishing and non-consumptive uses. Many of those parks were developed by the former Pearl River Basin Development District. At the southern end of the Pearl River, the Service and the LDWF manage over 60,000 acres of primarily forested wetlands. Portions of the Hancock County Marsh Preserve are located along the southeastern reaches of the Pearl River and are managed by the MDMR. The Nature Conservancy owns two areas in the lower basin: Mike’s Island and the 586-acre White Kitchen Preserve.

FISH AND WILDLIFE RESOURCE PROBLEMS AND PLANNING OBJECTIVES

A major challenge for wildlife conservation in the greater Jackson metropolitan area is the continued encroachment of urban development within the floodplain. The Service expects that the remaining fish and wildlife habitat values, acreage, and populations within the study area will decline in the future without the project due to the continued expansion of the greater Jackson urban area and continued encroachment into the Pearl River Basin floodplain. Development in these areas also results in reduced storage capacity of the floodplain and increasing flood damages during periods of floods. In turn, the increasing flood damages can encourage the development of more flood control projects. Further discussion of Pearl River Basin floodplain development can be found in the Pearl River Cumulative Impact Assessment Report (Gosselink et al. 1989).

The Service acknowledges the need to protect existing urban development from flood damages. However, other needs of the area include the protection of remaining fish and wildlife habitat values, including existing habitat for federally listed species and the conservation of at-risk species and their habitats within the Pearl River Basin. Maintaining wildlife habitat and values adjacent to urban areas adds to the overall quality of life. In addition, forested wetlands function as a natural area to store floodwaters and to filter and purify the water before it returns to the Pearl River system. Therefore, there is a need to restrict non-flood compatible development from flood-prone areas. Finally, in order to allow and encourage the citizens of Jackson to use the remaining fish and wildlife resources of the area, there is a need for improved access to the Pearl River.

Within the Pearl River Basin, as well as nationwide, bottomland hardwood forests and swamps have undergone a decline in acreage with 56 percent of southern bottomland hardwood and bald cypress forest being lost between 1900 and 1978 (MDFWP 2016). Even though there are ongoing restoration programs, substantial losses remain. The metropolitan areas surrounding

Jackson are expected to experience some of the highest population growth in the future (MDFWP 2016). Fragmentation caused by urban expansion will reduce biological diversity and impact sustainable wildlife production by reducing the size of available forest, thus creating areas incapable of supporting diverse ecological communities. When human populations reach approximately 45 people per square mile (PSM) the probability of a forest to properly function in regards to fish and wildlife resource values decreases to 50 percent; at 150 PSM the probability is 0 percent. Currently, Jackson and Hinds counties are at or above the higher PSM (MSDRWP 2016). While loss to development is reducing fish and wildlife habitat, the increasing conversion of hardwood forests and mixed pine-hardwood forests to pine plantations also results in a reduction in the quality of wildlife habitat even though those areas remain forested.

Impoundments can significantly affect riverine habitats, primarily by creating major areas of standing water with fewer habitat types than the natural river (Whitley and Campbell 1974). Pools are relatively shallow impoundments that retain some current but eliminate the currents and riffles required for spawning of sturgeon and blue sucker (Federal Interagency Stream Restoration Working Group 1998). Impoundments reduce fish diversity and change the relative abundance of species (Whitley and Campbell 1974). Lower turbidity levels, for example, induce phytoplankton production and create better conditions for sight feeding predators such as largemouth bass, which has long been the dominant bass species in impounded waters of the southern United States. Lake habitat within Mississippi, especially ponds, has increased in the last decade and has been determined to be common, widespread, and abundant (MDWFP 2016).

The expected population growth of Jackson could also result in a greater demand for future water withdrawals. Those withdrawals could compete with downstream flows during droughts and can impact fish populations through entrainment and impingement at pump sites.

The overall planning goal for feasibility studies should incorporate the co-equal needs of flood control and fish and wildlife conservation. To ensure that fish and wildlife resources receive equal consideration with other project purposes, the Service recommends the following planning objectives be adopted to guide future planning efforts:

- Important riverine habitats and fish communities should be conserved, protected, and restored where practicable to provide habitats representative of the natural river (including flowing waters, backwaters, and oxbow lakes). Any instream structures should provide for fish passage.

- Important terrestrial wildlife habitats (i.e., bottomland hardwoods, cypress swamps, riparian corridors, and sandbars) should be conserved, protected, and restored.

- Mitigation should be developed on a river basin basis to facilitate conservation of fish and wildlife resources.

- Detailed measures to offset fish and wildlife resource losses should be determined during feasibility studies.

In addition, alteration of the floodplain upstream and downstream of the project area has contributed to the decline in the overall function and values of the Pearl River as evidenced by the increase of at-risk species and species of conern within the watershed and the loss of species diversity. Therefore, an additional planning objective to address this basin-wide concern has been developed.

- A comprehensive assessment of changes of the Pearl River Basin hydrology and land use to determine their influence on flooding and the ecosystem response with a goal of identifying and developing ecosystem restoration projects that are coupled with flood risk reduction features throughout the basin.

Section 2036(a) of the Water Resources Development Act of 2007, Mitigation for Fish and Wildlife and Wetlands Losses, amended Section 906(b) of the Water Resources Act of 1986 to state that "Specifically mitigation plans shall ensure that impacts to bottomland hardwood forest are mitigated in-kind, and other habitat types are mitigated to not less than in-kind conditions, to the extent possible. In carrying out this subsection, the Secretary shall consult with appropriate Federal and non-Federal agencies." The Service's mitigation policy reflects this standard regarding in-kind mitigation.

The Service's Mitigation Policy (Federal Register, Vol. 46, pp. 7644-7663, January 23, 1981) has designated four resource categories, which ensure that the level of mitigation recommended will be consistent with the fish and wildlife resources involved. The mitigation planning goals and associated Service recommendations are based on those four categories, as follows:

> Resource Category 1 - Habitat to be impacted is of high value for evaluation species and is unique and irreplaceable on a national basis or in the ecoregion section. The mitigation goal for this Resource Category is that there should be no loss of existing habitat value.
>
> Resource Category 2 - Habitat to be impacted is of high value for evaluation species and is relatively scarce or becoming scarce on a national basis or in the ecoregion section. The mitigation goal for habitat placed in this category is that there should be no net loss of in-kind habitat value.
>
> Resource Category 3 - Habitat to be impacted is of high to medium value for evaluation species and is relatively abundant on a national basis. The Service's mitigation goal here is that there be no net loss of habitat value while minimizing loss of in-kind habitat value.
>
> Resource Category 4 - Habitat to be impacted is of medium to low value for evaluation species. The mitigation goal is to minimize loss of habitat value.

Considering the overall high value of cypress swamp and bottomland hardwood forests (i.e., forested wetlands), including their riparian component, and riverine habitat for fish and wildlife and the loss of that habitat type as previously mentioned, they are designated as Resource Category 2, the mitigation goal for which is no net loss of in-kind habitat value. The Service has also determined that the oxbow lakes and cutoffs functioning as oxbows within the existing floodplain area are Resource Category 2 habitat. Project features that would avoid impacts to

Category 2 resources should be selected over ones that would require conversion of forested wetlands to project purposes.

The scrub-shrub and upland habitat that may be impacted is placed in Resource Category 3 due either to their reduced value to wildlife and fisheries, degraded wetland functions, or abundance. The mitigation goal for Resource Category 3 habitats is no net loss of habitat value.

Due to their low flows and the impacts of the adjacent urban development, the Service classifies most of the tributary creeks that drain the project area as Resource Category 4, defined as habitat "... of medium to low value for evaluation species." The mitigation goal for Resource Category 4 habitat is to" ... minimize loss of habitat value." Cropland and pastureland is also classified as Resource Category 4.

DESCRIPTION OF TENTATIVELY SELECTED PLAN AND ALTERNATIVES

The District examined three alternatives in the final array: nonstructural, the levee plan, and the channel improvements/weir/levee plan (channel improvements alternative). Alternative A, the nonstructural alternative consists of relocations and buyouts to achieve flood control. While having little impact to fish and wildlife resources, Alternative A does not provide adequate flood protection within a reasonable cost; therefore, the Service will not address this alternative further in this report. Alternative B, the levee alternative consists of constructing new levees or floodwalls, expanding existing levees, and installing new pump stations. Alternative C, the channel improvements alternative consists of deepening the floodplain, constructing levees, and constructing a weir at the downstream end of the project area.

The TSP consists of the excavation of approximately 25 million cubic yards from approximately RM 284.0 to RM 293.5. The channel widening would range in width from approximately 400 to 2,000 feet. The channel would be excavated to varying depths to facilitate aquatic species habitat. It would also include the relocation of over approximately 4 miles of a levee further away from the river thus reconnecting some of the floodplain. In addition, the construction of a 1,500-foot-wide weir structure at approximately RM 284.0 to create a 1,901-acre improved channel (i.e., lake). Earthen material removed from the floodplain and river would be used to create approximately 947 acres of elevated fill adjacent to the excavated area and levees.

Activities needed to accomplish this work would include clearing and grubbing along all of the rights-of-way (ROWs) for all project features, construction of staging areas and access roads, and hauling of earthen fill for the levee. An existing 200-foot-wide weir for drinking water retention located at RM 291 within the project footprint would also be removed. The plan also includes installation of a 12-foot by 12-foot gate structure near and east of the weir to maintain minimum flows through the river channel system. A fish by-pass channel around the weir and low flow structure would be constructed on the east bank of the river.

The project would also include the creation of islands from approximately RM 289.5 to RM 292.0 to create and maintain habitat for wildlife species common to the area. In addition, to replace the approximately 31.4 acres of sandbars that would be lost, an equal or greater acreage would be recreated for turtle nesting habitat. The sandbars would be approximately 1 to 15 acres in size with sand approximately 2 feet deep. The sandbar would be no wider than 75 yards from the water line. The central ridge of the island should be 7 to 8 feet higher than the edges and vegetated with a narrow (<20 yards) strip of river birch or black willow trees. The created sandbars in conjunction with the proposed islands would be monitored and maintained through the life of the project to ensure that vegetative cover does not overtake the created open sand nesting areas. No wake zones would be established around the sandbars and human disturbance would be prohibited. Enforcement of the boat no-wake zones and disturbance restrictions would be within the authority of and undertaken by members of the FDCD. The sandbars would also be surrounded by tree tops and downed trees to create at least short-term basking and foraging areas and also serve to protect turtles from predation. The tree tops and downed trees would be placed approximately 10 to 20 feet apart around the created islands and along any of the shoreline that would be available for such uses.

Approximately 10 miles of river bank would also be protected as mitigation. The prioritized areas where this land would be located is; 1) north of the improved channel, 2) north of the Ross Barnett Reservoir, and 3) south of the weir. This action is in accordance with the ringed map turtle recovery plan. The relocation of ringed map turtles from Crystal Lake and the relocation of nests from the excavation area is also planned. Final environmental features will be developed during future design phases. An adaptive management and monitoring plan will be developed in conjunction with the Service and natural resource agencies which would provide ongoing monitoring, long-term management, and habitat protection benefits for the listed turtle. Additional mitigation options identified by LDWF include the restoration of sand and gravel mines and removal of the sills at Pools Bluff and Bogue Chitto. The protection and creation of gravel bars along with other possible mitigation features were identified by USACE as possible mitigation during the previous feasibility study.

Capping and stabilization of the Lafleur's and Gallatin Street Landfills would be undertaken, while some mitigative measures may be required at the Gulf States site. Further investigations to be undertaken in the detailed design phase are required to fully determine the extent of remediation needed. Remediation should eliminate the potential of leachates from flowing into the Pearl River.

The proposed action also includes the construction of an approximately 1,500-foot-wide weir located at RM 284. The top elevation of the weir would be at 258 feet North American Vertical Datum 1988 (NAVD 88). The weir will create an approximately 1,500-acre impoundment stretching from RM 284 to approximately RM 293 with an average depth of 22 feet. Current average depth is 6.7 feet. The 12-foot by 12-foot gate and culvert structure built to maintain minimum flows during low water periods would have a culvert bottom elevation on the upstream side of approximately 248 feet (NAVD 88) while the downstream side would connect to the existing channel at an elevation of approximately 230 feet (NAVD 88). An approximately 7,300-foot-long channel for fish passage would be constructed east of the low-flow structure and would have an upstream bottom elevation of 256 feet (NAVD 88) and the downstream bottom elevation would be 230 feet (NAVD 88) where it connects to the river channel.

Construction would also include an approximately 900-foot-long embankment with a top elevation of 260 feet (NAVD 88) within the floodplain to connect the weir to the fill areas on each side; the weir would be approximately centered in this embankment. Activities would include clearing and grubbing along all the ROWs for all project features, construction of staging areas and access roads, and hauling of earthen fill for the levee. Excavation of the weir site, low-flow structure, and fish passage channel would be necessary. Placement of erosion resistant material (e.g., stone or concrete) would be needed downstream of the weir, within the low-flow channel, and in the fish passage channel.

The construction plan indicates that most of the excavation from the Pearl River floodplain would occur during the dry season when the likelihood of out-of-bank flows is reduced. This provides a progressive level of flood risk management during construction and helps to minimize impacts to water quality and quantity. With flow contained within the River, the sediment load would not be impacted by the off-line excavation process during within-bank flow periods. Once constructed, the weir would fill by local rainfall events. The required minimum flows from the Ross Barnett Reservoir would be maintained at all times during construction. Once filled, the discharge over the weir and through the fish passage channel is designed to match the discharge from the Ross Barnett Reservoir.

The levee alternative (Alternative B) provides flood protection with fewer impacts to fish and wildlife resources, especially at-risk and listed species, than Alternative C. Alternative B is also designed to reduce risk of the 1% flood event (i.e., 100-year flood event). However, the Service recommends that Alternative B should include further modifications/features that would aid in achieving additional flood control benefits while avoiding and minimizing impacts, especially major modifications to the Pearl River and its floodplain. Some of the proposed modifications are features of Alternative C, the locally preferred alternative. Accordingly, the Service recommends that the levee alternative include the following features:

1. Levee setbacks, as proposed for Alternative C, are recommended to widen the floodplain and reduce flood stage elevations.

2. Excavation of the cleared floodplain to a lower elevation that would reduce water surface elevations while still allowing maintenance mowing is proposed. This could also be implemented in other areas where passage of flows is restricted, floodplain features prevent a more lateral dispersal of flood waters, or topography reduces the floodplain capacity. This should lower flood stages within these areas. Excavated soils, if suitable, should be used in levee construction. Floodplain excavation could also include removal of the floodplain portion of the Gallatin Street landfill near RM 285, a site identified in the draft FS/EIS that could be leaching chemicals into the groundwater and potentially into the Pearl River and other floodplain.

3. Conveyance improvements could be implemented around transportation embankments and lowering of the floodplain elevation in those areas could also be done.

4. Incorporation of other flood risk reduction features as needed to protect critical infrastructure.

These modifications to Alternative B would likely further improve flood protection, however, the Service does not determine flood risk reduction benefits so the degree of risk reduction they would provide is unknown. Furthermore, the Service does not know the degree to which these modifications would achieve the projects planning objectives but examination of such combinations is warranted. Variations of the TSP where the weir height or amount and/or extent of excavation needed to achieve project purposes was not presented.

DESCRIPTION OF IMPACTS

The Service has identified four primary fish and wildlife impacts related to the channel improvements alternative (Alternative C):

1) loss of habitat diversity and concomitant aquatic species diversity resulting from conversion of the Pearl River into a wide excavated channel (or relatively slack-water pool);

2) direct and indirect loss of riparian woodlands and other terrestrial habitats important to fish and wildlife resources;

3) loss of riverine sandbar habitat due to the increased water levels or to vegetation encroachment resulting from stabilized water levels in the pool; and

4) the potential extent/degree of resulting upstream and downstream channel re-adjustment or other hydrogeomorphic changes (e.g., bank erosion, channel incision) to the Pearl River, as well as tributaries, resulting from decreased sediment transport due to the weir. The Service is also concerned about impacts to public lands from hydrologic and geomorphic changes upstream and downstream, as well as reduced water flows and sediment delivery, especially to coastal marshes and potential future water withdrawals impacting downstream flows.

In general, impoundments adversely affect riverine fish communities by interrupting migratory movements and the downstream transport of sediments, organic matter, and nutrients; releases of water from dams may also increase downstream bank erosion and loss of sandbar and riparian habitats (Federal Interagency Stream Restoration Working Group 1998). The channel improvements alternative (Alternative C) would impact 2,856.62 acres (Table 4). The proposed new weir and excavation of approximately 25 million cubic yards of floodplain will replace 287 acres of riverine and adjacent habitats with a relatively slack-water pool of approximately 1,500 acres. The impacted acreage presented in this report is taken from the Environmental Appendix of the draft FS/EIS.

The impact of weirs (also referred to as low-head dams, channel dams, sills, and mill dams) on riverine systems has been studied. Those studies have included weirs of varying size, design (e.g., weir top below, even with or above channel banks), function, location, and age; thus somewhat complicating the forecasting of specific impacts. Nonetheless, there are impacts common to most all weirs.

To assess impacts, the Service examined discharge and velocity data. Because the low flow structure is designed to meet the required discharge of the Ross Barnett Reservoir, there will not be a change in the discharge from the proposed project. The range of velocities and water surface elevations presented in the tables below represent various flows with the 1,000 cfs discharge typically being equaled or exceeded about 54 percent of the time, the 2,000 cfs flow would be equaled or exceeded 42 percent of the time, the 5,000 cfs flow being equaled or exceeded 26 percent of the time, and 10,000 cfs flow being equaled or exceeded 13 percent of the time. Most of the discharges have their typical reoccurrence interval presented within the profile column. The weir would elevate the water surface from 258.1 feet (NAVD 88) to an approximate elevation of 260.95 feet (NAVD 88) for a river discharge of 20,000 cfs just upstream of the weir. Additional changes in water surface elevation are presented in Tables 5 through 9. As shown in the tables, the weir would elevate the water surface near the weir with greater differences being experienced when the river would have normally been at low flow conditions and smaller differences during larger discharge events. Velocity differences within the channel would also occur (velocities presented in the tables and graphs are an average over the channel's cross section) with velocities being reduced for the length of the project (Graph 4). This trend remains fairly constant throughout the improved channel portion (Tables 5 through 5 and Graph 4) with variations caused primarily by differences in the proposed cross-section of the channel. Upstream of the approximate upper limit of the pool area (between RM 293 and 294) the trend begins to diminish (Table 8 and Graph 4), but the influence of the weir is still detectable up to approximately RM 295.7.

Table 4. Cover types and acreage impacted by the channel improvements alternative, or tentatively selected plan (Alternative C).

Cover Types	Channel Improvements (acres)	Percentage of total acreage impacted
Emergent wetland	59.19	2.07
Lacustrine	200.09	7.00
Mixed Forested Wetland	911.58	31.91
Mixed Scrub-Shrub Wetland	256.04	8.96
Palustrine	147.20	5.15
Riverine	287.16	10.05
Upland Evergreen Forest	14.44	0.51
Upland Grassland	151.79	5.31
Upland Mixed Forest	536.47	18.70
Upland Pasture	54.41	1.9
Upland Scrub-Shrub	208.68	7.31
Upland Urban	29.60	1.04
Total	**2,856.62**	**100**

Based on an ANOVA analysis of the 20,000 cfs and 40,000 cfs discharges, the post-project velocities will be significantly reduced for the entire project area at a discharge of 20,000 cfs. Post-project velocities will be significantly reduced in the improved channel reach and will increase in the upstream reach. The channelized reach is projected to have reduced velocities at all discharges below 20,000 cfs, but not at 40,000 cfs or greater; whereas the upper reach will see post-project velocity increases at 40,000 cfs and greater but not at 20,000 cfs or below. Once discharges decrease below 10,000 cfs, the improved channel's velocities would significantly decrease and lake like velocities would occur.

Between RM 293.9 (upper end of the improved channel) and RM 295.9 the river and floodplain will not be altered, but the water surface elevation will be reduced several feet for discharges between 10,000 cfs and 50,000 cfs. In this same general area there will be an increase in velocities (i.e., 1.28 feet per second [fps] to 5.85 fps) for discharges greater than 40,000 cfs

Table 5. Hydrologic information for just above the proposed weir

River Mile	Profile	Plan	Discharge	Water Surface Elevation	Velocity Total	Area	Top Width
			(cfs)	(ft)	(ft/s)	(sq ft)	(ft)
284.833	-	Existing	1000.00	238.43	1.17	851.32	137.08
284.833	-	Alt C	1000.00	258.40	0.05	22369.18	3182.28
284.833	-	Existing	10000.00	252.55	2.08	7497.75	1660.40
284.833	-	Alt C	10000.00	259.86	0.45	27544.17	3932.60
284.833	-	Existing	20000.00	258.10	2.09	19673.79	3698.12
284.833	-	Alt C	20000.00	260.95	0.83	32053.53	4378.40
284.833	2 YR	Existing	40000.00	264.05	1.67	55605.10	9560.92
284.833	2 YR	Alt C	40000.00	264.27	1.21	53155.65	8360.21
284.833	5 YR	Existing	50000.00	266.13	1.40	76860.01	10733.41
284.833	5 YR	Alt C	50000.00	266.32	1.18	71379.16	9239.55
284.833	10 YR	Existing	56800.00	267.20	1.35	88425.55	10858.47
284.833	10 YR	Alt C	56800.00	267.39	1.21	81291.73	9339.00
284.833	25 YR	Existing	73000.00	269.36	1.32	112014.10	10992.36
284.833	25 YR	Alt C	73000.00	269.55	1.27	101675.40	9469.48
284.833	50 YR	Existing	90000.00	271.42	1.23	134758.50	11070.64
284.833	50 YR	Alt C	90000.00	271.60	1.25	121130.50	9517.18
284.833	100 YR	Existing	106000.00	272.86	1.23	150825.60	11154.90
284.833	100 YR	Alt C	106000.00	273.06	1.28	135026.70	9594.28

Table 6. Hydrologic information for the area between I-20 and US 80							
River Mile	Profile	Plan	Discharge	Water Surface Elevation	Velocity Total	Area	Top Width
			(cfs)	(ft)	(ft/s)	(sq ft)	(ft)
287.14	-	Existing	1000.00	240.61	1.17	853.71	261.04
287.14	-	Alt C	1000.00	258.40	0.05	19424.23	1538.63
287.14	-	Existing	10000.00	254.29	1.14	8748.41	924.12
287.14	-	Alt C	10000.00	259.89	0.46	21717.10	1549.71
287.14	-	Existing	20000.00	259.79	1.40	17500.82	2262.55
287.14	-	Alt C	20000.00	261.03	0.85	23490.22	1557.56
287.14	2 YR	Existing	40000.00	265.84	1.45	31340.73	2310.40
287.14	2 YR	Alt C	40000.00	264.44	1.39	28841.54	1580.90
287.14	5 YR	Existing	50000.00	267.95	1.53	36962.38	2923.83
287.14	5 YR	Alt C	50000.00	266.51	1.56	32175.60	1786.84
287.14	10 YR	Existing	56800.00	269.10	1.61	40784.96	3839.39
287.14	10 YR	Alt C	56800.00	267.60	1.68	34312.81	2080.83
287.14	25 YR	Existing	73000.00	271.49	1.77	50877.87	4396.79
287.14	25 YR	Alt C	73000.00	269.82	1.95	40371.36	3382.07
287.14	50 YR	Existing	90000.00	273.71	1.93	60780.36	4521.68
287.14	50 YR	Alt C	90000.00	272.07	2.18	48410.02	3690.79
287.14	100 YR	Existing	106000.00	275.31	2.05	68093.63	4626.52
287.14	100 YR	Alt C	106000.00	273.53	2.43	53838.36	3779.51

Table 7. Hydrologic Information for the area between E. Fortification St. and the Water Works Weir							
River Mile	Profile	Plan	Discharge	Water Surface Elevation	Velocity Total	Area	Top Width
			(cfs)	(ft)	(ft/s)	(sq ft)	(ft)
290.45	-	Existing	1000.00	245.90	0.95	1048.46	317.47
290.45	-	Alt C	1000.00	258.40	0.05	21878.94	2269.97
290.45	-	Existing	10000.00	257.62	1.76	5689.12	594.83
290.45	-	Alt C	10000.00	259.95	0.39	25419.89	2321.46
290.45	-	Existing	20000.00	262.75	1.76	13908.46	3172.01
290.45	-	Alt C	20000.00	261.22	0.70	28421.88	2518.79
290.45	2 YR	Existing	40000.00	268.86	1.14	35196.52	3674.10
290.45	2 YR	Alt C	40000.00	264.87	1.02	39105.57	3170.99
290.45	5 YR	Existing	50000.00	271.14	1.14	44007.17	3926.98
290.45	5 YR	Alt C	50000.00	267.03	1.08	46106.50	3254.74
290.45	10 YR	Existing	56800.00	272.47	1.15	49241.71	3945.49
290.45	10 YR	Alt C	56800.00	268.18	1.14	49867.96	3261.55
290.45	25 YR	Existing	73000.00	275.28	1.21	60388.65	3982.73
290.45	25 YR	Alt C	73000.00	270.57	1.27	57677.16	3275.64
290.45	50 YR	Existing	90000.00	277.87	1.27	70733.42	4017.11
290.45	50 YR	Alt C	90000.00	273.00	1.37	65663.00	3289.99
290.45	100 YR	Existing	106000.00	279.81	1.35	78652.36	4126.38
290.45	100 YR	Alt C	106000.00	274.64	1.49	71065.68	3299.67

Table 8. Hydrologic Information for the area west of West Brook Road							
River Mile	Profile	Plan	Discharge	Water Surface Elevation	Velocity Total	Area	Top Width
			(cfs)	(ft)	(ft/s)	(sq ft)	(ft)
296.97	-	Existing	1000.00	257.63	0.62	1609.83	231.92
296.97	-	Alt C	1000.00	259.75	0.47	2122.42	253.08
296.97	-	Existing	10000.00	269.24	0.78	20771.13	3995.13
296.97	-	Alt C	10000.00	269.19	0.79	20576.61	3987.73
296.97	-	Existing	20000.00	272.31	0.80	33662.45	4455.25
296.97	-	Alt C	20000.00	272.00	0.85	32301.14	4406.09
296.97	2 YR	Existing	40000.00	276.60	0.83	75028.88	15085.07
296.97	2 YR	Alt C	40000.00	274.92	1.13	50409.55	11567.84
296.97	5 YR	Existing	50000.00	278.10	0.71	97764.01	15168.44
296.97	5 YR	Alt C	50000.00	276.45	1.08	72749.08	15056.12
296.97	10 YR	Existing	56800.00	278.95	0.68	110724.90	15273.98
296.97	10 YR	Alt C	56800.00	277.65	0.90	90890.41	15151.87
296.97	25 YR	Existing	73000.00	280.93	0.64	142711.00	16808.10
296.97	25 YR	Alt C	73000.00	279.04	0.86	112029.10	15294.21
296.97	50 YR	Existing	90000.00	283.05	0.60	178789.70	17312.04
296.97	50 YR	Alt C	90000.00	280.26	0.87	131434.40	16488.18
296.97	100 YR	Existing	106000.00	284.97	0.58	212963.00	18255.88
296.97	100 YR	Alt C	106000.00	281.31	0.88	148966.60	16866.23

Table 9. Hydrologic Information for the area just downstream of the dam							
River Mile	Profile	Plan	Discharge	Water Surface Elevation	Velocity Total	Area	Top Width
			(cfs)	(ft)	(ft/s)	(sq ft)	(ft)
302.08	-	Alt C	1000.00	260.43	0.22	4546.82	458.15
302.08	-	Existing	10000.00	271.43	0.97	29436.15	5112.16
302.08	-	Alt C	10000.00	271.41	0.97	29332.66	5102.81
302.08	-	Existing	20000.00	275.02	1.56	53490.64	9232.33
302.08	-	Alt C	20000.00	274.91	1.57	52479.26	8773.74
302.08	2 YR	Existing	40000.00	279.69	0.70	113204.30	14348.72
302.08	2 YR	Alt C	40000.00	278.87	0.86	101558.70	13996.55
302.08	5 YR	Existing	50000.00	281.29	0.63	136908.00	15164.46
302.08	5 YR	Alt C	50000.00	280.72	0.71	128334.60	14970.76
302.08	10 YR	Existing	56800.00	282.08	0.62	149088.10	15300.98
302.08	10 YR	Alt C	56800.00	281.73	0.66	143659.50	15255.45
302.08	25 YR	Existing	73000.00	283.85	0.62	176337.50	15655.02
302.08	25 YR	Alt C	73000.00	283.22	0.67	166599.30	15505.50
302.08	50 YR	Existing	90000.00	285.61	0.61	204424.70	16313.44
302.08	50 YR	Alt C	90000.00	284.56	0.69	187586.40	15840.08
302.08	100 YR	Existing	106000.00	287.28	0.61	232381.90	17105.22
302.08	100 YR	Alt C	106000.00	285.68	0.72	205577.00	16334.50

(shaded area in Graph 4). This decrease in water surface and increase in velocities could result in scouring and destabilization of the banks (i.e., head cutting), a sheer strength analysis has shown that water velocities would be well below the critical thresholds that would result in channel instability or erosion.

The weir is designed to be overtopped by the discharges occurring at the one-year frequency or greater. Studies have investigated geomorphological impacts from similar weirs. Gangloff et al. (2011) found narrower channel widths in streams with intact weirs. Helms et al. (2011) found intense sedimentation and altered geomorphology in upstream areas and immediately downstream of the weir. Pearson et al. (2016) observed that floodplains upstream of dams received larger amounts of sediment (including sand) during over bank floods. Ciski (2014) found that weirs with tops below channel banks still captured fine sediments and sand, but trapping of fines was minor and no major discontinuities in river morphology or sediment characteristics occurred. Skalak et al. (2009) discovered coarsening of downstream sediments. Ciski and Rhoads (2010) observed that if the weir does trap sediment, then downstream erosion of channel banks and the channel bed will occur through the formation of an inflection point in the water surface profile; this inflection or "nick" point would migrate toward the structure diminishing the extent of the backwater (i.e., sedimentation) zone. Sluice gates within the structure helped pass sediments downstream. Fencl et al. (2017) also found that the substrate coarsened downstream, but that a maximum of 1.6 miles downstream, the substrate returned to reference site conditions. The downstream area altered by weirs (i.e., widening and substrate changes) ranged from 0.13 to 1.6 miles with an average of 0.75 miles. The changes in the river's width and depth depended on local factors including geology, channel confinement, slope, and height of dam compared to bank height. Sedimentation starvation below dams can reduce the effect of downstream low-head dams. Upstream areas experienced an increase in mean depths. The impacted upstream area can vary by the slope of the river and the height of the weir. To assess the potential capture of sediments, the FDCD contracted with Tetra Tech to develop a model of the area to compare existing conditions against those with the project constructed. The Tetra Tech model was developed on behalf of the Mississippi Department of Environmental Quality (MDEQ). This model uses Environmental Fluid Dynamics Code (EFDC) and Water Quality Analysis Simulation Program (WASP) to create a dynamic one-dimensional model from Jackson, MS, to Bogalusa, LA, and simulates hydraulics and water quality from January 1, 2000, through December 31, 2017. In addition to using 18 years of data, the model accounts for many hydraulic variables, including discharge flows (Table 10) and total suspended solids (Table 10). Implementation of the project results in less than 0.3 percent change in either direction for either variable. Based on this analysis they determined that the project is not predicted to impact sediment load or downstream discharges (and thereby downstream velocities); thus, the project would not be expected to affect the amount of sediment that would or would not be picked up downstream of the project area. However, within the Engineering Appendix a preliminary sediment transport analysis was conducted. That analysis indicated a reduction of sediment transport, especially at lower flows between approximately RM 285 and 290. This would indicate a potential sediment sink within the lake portion; and the appendix did state the need for additional sediment analysis. Reduced sediment transport could result in increased downstream erosion. To address that issue, monitoring at the weir and downstream for 1.6 miles would be

Table 10. Modeled Water Quality Parameters pre and post

	Depth (ft)							
	Existing				Channel Improvements			
	Mean	Median	5%Tile	95%Tile	Mean	Median	5%Tile	95%Tile
Project Area	6.7	4.8	1.3	18.6	22.1	21.9	20.3	24.0

	Flow (cfs)							
	Existing				Channel Improvements			
	Mean	Median	5%Tile	95%Tile	Mean	Median	5%Tile	95%Tile
Project Area	3988.0	1320.0	212.8	16268.2	3991.8	1315.4	247.5	16273.4

	Temperature (F)							
	Existing				Channel Improvements			
	Mean	Median	5%Tile	95%Tile	Mean	Median	5%Tile	95%Tile
Project Area	68.7	68.7	50.3	87.4	69.0	69.1	49.1	88.2

	Biochemical Oxygen Demand (mg/L)							
	Existing				Channel Improvements			
	Mean	Median	5%Tile	95%Tile	Mean	Median	5%Tile	95%Tile
Project Area	10.7	10.8	10.6	10.8	6.9	7.5	1.8	10.5

	Dissolved Oxygen (mg/L)							
	Existing				Channel Improvements			
	Mean	Median	5%Tile	95%Tile	Mean	Median	5%Tile	95%Tile
Project Area	8.4	8.1	5.8	11.4	8.4	8.2	6.2	10.9

	Total Nitrogen (mg/L)							
	Existing				Channel Improvements			
	Mean	Median	5%Tile	95%Tile	Mean	Median	5%Tile	95%Tile
Project Area	0.94	0.93	0.74	1.10	0.90	0.92	0.68	1.05

	Total Phosphorus (mg/L)							
	Existing				Channel Improvements			
	Mean	Median	5%Tile	95%Tile	Mean	Median	5%Tile	95%Tile
Project Area	0.11	0.11	0.08	0.14	0.11	0.11	0.08	0.14

	Chlorophyll a (ug/L)							
	Existing				Channel Improvements			
	Mean	Median	5%Tile	95%Tile	Mean	Median	5%Tile	95%Tile
Project Area	2.14	1.98	1.93	2.74	1.97	1.21	0.02	9.53

	Total Suspended Solids (mg/L)							
	Existing				Channel Improvements			
	Mean	Median	5%Tile	95%Tile	Mean	Median	5%Tile	95%Tile
Project Area	32.6	28.9	13.4	63.2	31.0	26.8	13.1	62.1

incorporated into the monitoring and adaptive management plan. If impacts are detected additional mitigation would be necessary.

Cumming's (2004) examination of low head dams determined that the biggest issue is anthropogenic influences impacting water quality within the created water body including temperature. Butts and Evans (1978) found that channel dams resulted in lower DO levels within the pool and that the downstream design of the weir influenced the amount of oxygen reintroduced to the water column. Ramped weirs had less re-aeration than water falling over vertical weirs but the greatest influences on DO levels were the water velocity over the dam and the distance water fell. Data within the study displays that DO levels within the pool may exhibit wider DO fluctuations like those typically associated with ponds. Helms et al. (2011) found no physiochemical changes associated with mill dams, and Smith et al. (2017) found that dams did not impact local abiotic factors. Gangloff et al. (2011) found that streams with weirs had lower nitrogen concentrations but observed few statistical differences between habitat variables measured in streams with intact, breached, and relict low-head dams. Santucci et al. (2005) observed that DO and pH levels in pools experienced wide daily fluctuations and at times did not meet state water quality standards. Within the proposed project area there are eight streams draining approximately 61 square miles of predominately urban areas. The impact of those primarily urban drainages to the proposed pool water quality has not been determined, but drainage from urban areas typically has increased nutrient loadings and concentrations of pesticides, herbicides, and various hydrocarbon products. High nutrient levels could result in eutrophication of the proposed waterbody. Fluctuations and stratifications in the water quality (e.g., DO) similar to what occurs in the Ross Barnett Reservoir could be expected. To assess water quality the same Tetra Tech model was used. Parameters examined included temperature, dissolved oxygen (DO), total phosphorus, total suspended solids, biological oxygen demand (BOD), total nitrogen and chlorophyll a. Slight differences were noted for many of the parameters (Table 8) but no significant adverse effects were revealed.

Santucci et al. (2005) studied the impacts of weirs to macroinvertebrates and discovered that species distribution was truncated. Free-flowing river reaches supported a higher quality macroinvertebrate community while pool communities consisted of relatively few taxa dominated by oligochaetes and chironomid larvae that are more tolerant of poorer water quality. Gangloff (2011) observed that mussel populations upstream of dams had a greater number of historical mussel species. Conversely, Dean et al. (2002) found fewer species upstream and within the influence of the weir resulting from deeper water, slower velocity and silty substrates. Potential upstream impacts to mussels and fish could also result due to changes in tributary velocities upstream of the pool (Roghair et al., 2016). The response of mussels to weirs varies according to individual species tolerance to changes resulting from the weir, including changes in sedimentation rates, suspended sediments, and water quality (Early 2006; Gailbraith 2018; Tieman et al. 2016). It is reasonable to assume that the proposed pool would experience changes in macroinvertebrate and mussel communities based on the individual species tolerance to water quality and sedimentation changes.

Smith et al. (2017) determined that darter species, riffle specialists, and taxa susceptible to poor water quality were absent from river reaches affected by multiple low-head weirs. With increasing distance downstream from the dam typical riverine species became more prevalent. Tipton et al. (2004) stated that areas in the Pearl River experiencing greater geomorphological instability had fewer darters, and those areas of instability were attributed to the Ross Barnett Reservoir. Examination of long-term fishery samples from within the same approximate area by Piller et al. (2004) found a decline in the at-risk frecklebelly madtom and other species associated with gravel substrate. Piller et al. (2004) attributed these declines to channel changes and loss of gravel substrate resulting from water resource projects (e.g., water storage, navigation) and poor agricultural practices that destabilized the river and increased sedimentation. Helms et al. (2011) observed species richness was lower upstream of dams. Weirs can interrupt fish migration (Smith et al. 2017), and genetic divergence resulting from such separation has been documented (Haponski et al. 2007). Benstead et al. (1999) identified an increase in the entrainment of larval shrimp from water withdrawals associated with low-head dams.

Impacts associated with the proposed weir would include many of those described above. The upstream pool would likely capture any coarser sands entering the pool and would retain some finer grain sizes; however, as grain size decreases the likelihood of retention would decrease. The net loss of this sediment would likely result in the geomorphological changes immediately downstream and extending up to 1.6 miles downstream. Bank erosion and channel deepening are likely occur. The resulting destabilization of the Pearl River would likely result in decreased habitat quality for at-risk and riverine dependent aquatic species and possible localized reductions in their populations (e.g., frecklebelly madtom, Pearl map turtle, etc.) downstream of the weir. The proposed fish passage around the weir would allow continued fish migration for such species as the Gulf sturgeon, American shad, American eel, and southeastern blue sucker. Future design work for the project should further develop the design of the fish passage, and measures, including operational actions, to maintain downstream water quality and sediment transport (including operation of the sluice gate to by-pass sediments as needed).

Where water surface elevations are likely to increase in some tributary waterbodies and decrease in others, increased bank erosion and/or channel incision (i.e., head cutting) may occur in those streams, however, some of the tributaries in the project area are concrete lined or have been stabilized with rip-rap. In addition, a large portion of many of the tributaries have been channelized and/or lost most of the riparian vegetation. Shifts in composition and decreases in diversity of benthic macroinvertebrate species and fish species may result due to changes in substrate and water depth characteristics post-project (Fruget 1992) in those areas still possessing more natural tributary characteristics.

Until vegetative cover is established on the levees and river banks following construction, all disturbed areas would be subject to erosion. This eroded material could be carried into the Pearl River system. This turbidity would be additive to any downstream riverbank erosion resulting from the current instability. Increased turbidity can result in decreased light penetration and decreased photosynthesis. High levels of sediment can settle on fish spawning areas and smother fish eggs and larvae. Production of benthic organisms can also be reduced by high levels of sediment. Further, sediments can settle on respiratory surfaces of fish and aquatic organisms and interfere with respiration. Turbidity can also interfere with mussel reproduction by reducing the ability of prey to see the parasitic life stage of freshwater mussels by foraging fish. Best Management Practices (BMPs) for construction sites would be followed.

Downstream water quality associated with disturbance/excavation of or around two former landfills (Gallatin Street and Jefferson Street) and the former Gulf States Creosote plant found within the proposed project area is a concern. The 62-acre Gallatin Street landfill contains urban and industrial trash. Leachates from within the site contained cadmium, lead, and nickel above the regulatory standards. Debris from this landfill is reported to be washing into the river. The 45-acre Jefferson Street (or Lafleurs Landing) landfill also has debris that can be eroded during high river stages. Remediation of these sites is planned for during construction. Details of the remedation have not yet been developed so impacts associated with the remediation and potential success are not fully known.

Terrestrial habitat impacts associated with the project are a result of the direct conversion of wildlife habitat to project features. The excavation of approximately 25 million cubic yards within the floodplain, improvement to and relocation of existing levees, construction of new levees, placement of excess material adjacent to the levees would result in the loss of over 1,314.8 acres of wetlands of which most is bottomland hardwood habitat with some swamp and shrub/scrub (shrub land) habitat. Fragmentation of remaining forested areas by the construction of the levees would further reduce their value to fish and wildlife resources. Forest fragmentation can contribute to population declines in some avian species because fragmentation reduces avian reproductive success (Robinson et al. 1995). The Service is especially concerned when those impacts affect nesting forest interior migratory birds of conservation concern (https://www.fws.gov/migratorybirds/pdf/grants/ BirdsofConservationConcern2008.pdf). Many migratory birds of conservation concern require large blocks of contiguous habitat to successfully reproduce and survive.

<u>At-risk and species of concern</u>

The Service specifically addresses impacts to at-risk and species of concern in this section because of our concern regarding the impacts to those species and the need to conserve those species wherever they are currently found. The Service expects the preferred alternative (Alternative C, channel improvement plan) to have long-term negative impacts to six of the seven aquatic species potentially found within the action area. Although there may be short-term negative impacts to the Alligator snapping turtle during construction, the species is expected to persist long-term in the impoundment as this species' preferred habitat includes slow-moving waters that the impoundment should continue to provide but would no longer have structure (e.g., tree roots, snags, etc.) where it is typically found. Therefore, the Service does not anticipate long-term significant negative impacts to the Alligator snapping turtle because of the project, but due to the removal of all structure within the impoundment the number of turtles may be lower than typically found in other lake like waterbodies. Placement of trees around the man-made beaches would help offset the loss of such structure and partially mitigate such impacts.

The partial impounding of the Pearl River via weir construction and the resulting creation of a 9.5-mile-long pool will result in the removal of riverine features (i.e. swifter flowing water, snags, etc.,) that provide suitable habitat for the remaining at-risk species. The Service anticipates that the pool area would provide no to low habitat value for the frecklebelly madtom due to lentic conditions. If any populations of the Alabama hickorynut, delicate spike, and Pascagoula creekshell are present in the project area they are not likely to remain viable within the impounded reach of the river due to the loss of riverine conditions and stratification leading to hypoxic conditions near the lake bottom. The channel improvement would also preclude any future restoration efforts for those species in the unchannelized areas. The Service also anticipates that the impoundment will negatively affect the Pearl River map turtle; however, it is possible the species will continue to exist within the impoundment albeit in very low numbers. The Service does not expect that the impoundment will provide for a viable population because other turtle species (red-eared slider) more adapted to slow-flow conditions would likely flourish in the impoundment (Selman 2018).

<u>Impacts of Levee Alternative:</u>

Land would be required for the levees, floodgates, and required project rights-of-way as well as for borrow areas (Table 11). The selected plan levee alignments traverse cleared land as well as forestland, including bottomland hardwood areas. A grass-covered levee would provide minimum habitat value while land that is presently forested, especially with bottomland hardwoods, provides habitat of high value. Therefore, there would be a significant decrease in habitat value as forestland is converted to levees. Cleared land (e.g., cropland, pasture, abandoned fields) provides habitat of less value than forestland but of more value than levees; thus, there would also be some loss of habitat value as cleared land is converted to levees. Alternative B (the levee plan) would impact 785.8 acres of habitat as displayed below.

Table 11. Cover types and acreage impacted by the Levee Plan (Alternative B).

Cover Types	**Levee (acres)**	**Percent**
Emergent wetland	5.88	0.75
Lacustrine	28.24	3.59
Mixed Forested Wetland	291.49	37.10
Mixed Scrub-Shrub Wetland	30.12	3.83
Palustrine	18.54	2.36
Riverine	9.42	1.2
Upland Evergreen Forest	16.26	2.07
Upland Grassland	37.68	4.8
Upland Mixed Forest	326.88	41.6
Upland Pasture	-0-	-0-
Upland Scrub-Shrub	8.89	1.13
Upland Urban	12.39	1.58
Total	**785.80**	**100**

Undeveloped floodplain land that would receive flood protection would be subject to conversion to urban development. Undeveloped areas include cleared and wooded lands, some of which are wetlands. As developed urban land, these areas would have much less value to wildlife. Even if undeveloped forested areas within the protected area were not developed, there would be some loss of wildlife habitat value through additional changes in hydrology and further fragmentation of forested lands.

The land between the levees, as well as the Pearl River itself, would also be altered and undergo changes in habitat values. Changes in the hydrologic characteristics of the flood plain would be confined to those flows that are in the overbank area of the Pearl River. A flow with a recurrence interval of two years is contained within the top bank. Therefore, the project would affect those flows that occur out of bank having an approximate recurrence interval of five years or more. As a result, duration and frequency of water levels on any sandbars within the Pearl River should not change significantly, and there should be no major adverse affects to species using sand bar habitat. As most levee alignments would remain the same except where setbacks occur (i.e., widening of the floodplain) there should not be an increase in velocities and resulting habitat modifications due to increased water velocities.

Habitat impacts associated with the levee alternative are primarily related to the direct conversion of fish and wildlife habitat to project purposes and to changes in habitat due to operation and maintenance of the project. Those areas newly protected by levees but adjacent to tributary streams could still have back water flow from the Pearl River on an annual basis, but would not receive the benefits from a major flood event when floodgates would be closed. Floodgates would not be closed until flood events greater the five-year flooding frequency occurred.

During the construction period and until a vegetative cover is established on the cleared areas and levees, the levees and all disturbed areas would be subject to erosion. This eroded material would be carried into the Pearl River system. This turbidity would be additive to any downstream riverbank erosion resulting from sediments being trapped behind the weir. Increased sediment and turbidity can result in decreased light penetration and decreased photosynthesis. High levels of sediment can settle on fish spawning areas and smother fish eggs and larvae. Production of benthic organisms also can be reduced by high levels of sediment. Further, sediments can settle on respiratory surfaces of fish and aquatic organisms and interfere with respiration.

Overall, the acreage of impacts associated with Alternative C (channel improvement plan) are 1,955.24 acres greater than those associated with Alternative B (levee plan) (Table 12).

While the Service has not quantified any of the potential impacts associated with the Service proposed modifications to the levee plan (Alternative B), those modifications could result in additional impacts greater than those presented above but still significantly less than those resulting from Channel Improvement (Alternative C). Relocation of the levee would expand the floodplain and would restore some hydrology functions of that part of the floodplain.

Table 12. Comparison of acres impacted for the Tentatively Selected Plan (Alternative C, channel improvements plan) and the levee plan (Alternative B).

Cover Type	Acres/Impact Area*		Difference
	Channel Improvements	Levee	
Emergent	59.19	5.88	53.31
Lacustrine	200.09	28.24	171.85
Mixed forested wetlands	911.58	291.49	620.09
Mixed scrub wetlands	256.04	30.12	225.92
Palustrine	147.20	18.54	128.66
Riverine	287.16	9.42	277.74
Upland evergreen forest	14.44	16.26	-1.82
Upland grassland	151.79	37.68	114.11
Upland mixed forest	536.47	326.88	200.59
Upland pasture	54.41	0	54.41
Upland shrub-land	208.68	8.89	199.79
Upland urban	29.60	12.39	17.21
Total	**2,856.62**	**785.80**	**1955.24**

*Acres are taken from the June 2018 Draft Final EIS, Appendix D Environmental, October 2014 Habitat Evaluation Procedures (HEP) Report.

HABITAT EVALUATION PROCEDURES ANALYSIS

The District's consultant used the Habitat Evaluation Procedures (HEP) (Service 1980a, 1980b) to quantify the potential impacts to fish and wildlife species resulting from construction. HEP is a habitat-based evaluation system that allows estimates of current habitat conditions, predictions about future conditions and comparison between alternatives, and aids in devising mitigation strategies, all without the need for direct sampling of animal populations. The sampling and calculation of impacts and mitigation were undertaken by the District's consultant.

HEP is based on the fundamental assumption that the quantity and quality of a habitat can be numerically documented and reasonably predicted for future conditions. This numerical description is represented by the Habitat Suitability Index (HSI) and the area of available habitat for a particular species. The numerical range of the HSI is from 0.0, which represents no habitat value for an evaluation species to 1.0 representing optimum habitat value. This is a linear index with the degree of difference between 0.0 and 0.1 the same as the degree of difference between 0.9 and 1.0. Multiplying the HSI by the area results in Habitat Unit (HU) data which form the essence of the HEP methodology. These HUs serve not only as the principal units of comparison in HEP, but also as a means of communicating the gains and losses in habitat resulting from management activities and project implementation.

Most Federal agencies use annualization as a means to display benefits and costs of a project. Federal projects are evaluated over a period of time that is referred to as the period of analysis. This is defined as that period between the time that the project becomes operational and the end of the period of analysis (typically 50 years). Habitat unit gains or losses are annualized by summing the cumulative HUs across all impact intervals in the period of analysis and dividing the total HUs by the period of analysis. The result of this calculation is called Average Annual Habitat Units (AAHUs).

AAHUs for each evaluation species are calculated by summing HUs for successive years and dividing by the period of analysis. Determining the net impacts of a proposed alternative requires that two future annualizations be performed and compared to one another. These future predictions are the expected future conditions with and without the proposed alternative. The net impact computation reflects the difference in AAHUs between the future with and without the project. The change (increase or decrease) in AAHUs under each future with-project condition, compared to future without-project condition, provides a quantitative comparison of project impacts that are expected to occur with each project alternative. An increase in average annual habitat units indicates that the project is beneficial to the evaluation species; a decrease in average annual habitat units indicates that the project is damaging to the evaluation species.

It is not logistically feasible to analyze habitat impacts to all of the species that occupy the project area. Selection of a limited number of species from a larger set is necessary. Sixteen evaluation species were selected by the consultants to represent the various habitats impacted by the project. Those evaluation species included barred owl, gray squirrel, swamp rabbit, brown thrasher, eastern meadowlark, slider turtle, black crappie, bluegill, channel catfish, common carp, great blue heron, great egret, largemouth bass, redear sunfish, white crappie, and wood duck. These species have been utilized by the Service in past analysis of flood control projects for the Jackson area, however, they were selected to analyze a levee project that would not impact riverine habitat.

It should be noted that the impact and mitigation analysis undertaken by the USACE's Engineering Research and Development Center (ERDC) for the previous planning efforts alternative was presented in Appendix C of Appendix D, Environmental. That analysis utilized riverine dependent species, thus capturing riverine impacts that would not have been captured with the use of the above HEP species. This allowed impacts to lacustrine, backwater, and riverine species and habitats to be analyzed separately, and separate riverine mitigation concepts/ideas formulated in accordance with our mitigation policy. The Service endorses and supports this approach to ensure riverine impacts are fully mitigated and recommends it be used in future planning efforts to determine appropriate mitigation. Their analysis indicated that riverine obligated species (e.g., darters, suckers) would no longer persist after construction and facultative riverine species (e.g., catfish, shiners, minnows) numbers would decrease. These two guilds represent twenty-percent of the Pearl River fish assemblage.

HEP allows the determination of mitigation using one of three compensation goals. In-kind (no trade-off) is to precisely offset the HUs lost for each evaluation species; thus, requiring the list of negatively impacted species from the impact analysis and the mitigation area to be the same. The equal replacement (equal trade-off) goal allows the HUs lost by a species to be offset by the gain in an equal number of HUs from another species allowing the list of species used in the impact and mitigation analysis to differ. The relative replacement (relative trade-off) allows one HU for an evaluation species to be used to offset the loss of another species at a differential rate depending on the species involved. A more complete discussion of the HEP procedures, survey data, and results can be found in Appendix D, within the subsection entitled Draft Evaluation of Impacts to Terrestrial and Aquatic Habitats Resulting from Alternatives for the Rankin-Hinds County, Mississippi, Flood Damage Reduction Study.

The HEP analysis for Alternative C (channel improvements plan) determined that the creation of the pool-like environment behind the weir would fully compensate for all aquatic habitat impacts; however, this supposition did not account for the need to mitigate riverine impacts in-kind. The determination of compensation areas for terrestrial impacts via HEP contemplated three alternative management scenarios: acquisition, restoration, and regeneration. The acquisition scenario included acquisition of existing forestland and preservation of existing habitats via a long-term management plan. The restoration scenario assumes that every existing habitat type found within the project area could and would be restored at some other location within the Pearl River Basin. The regeneration scenario included the regeneration of the dominant habitat type within the proposed project area. Under that 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 area. The acreage required to mitigate Alternative C (channel improvement plan) via the acquisition, restoration, and regeneration scenarios using the in-kind goal (each individual evaluation species losses are offset) and the equal replacement goal (all lost habitat units are offset) are presented below.

Impacted riverine species would benefit from the proposed protection of 10 miles of river bank and other aquatic features developed during Endangered Species Consultation. However, it has not been determined if these measures would fully mitigate AAHUs lost by riverine species, therefore, modification of the mitigation plan may be necessary during detailed design and construction phases. Aquatic mitigation measures could include those identified by ERDC, LDWF, and Kennedy and Hasse (2009).

Table 13. Mitigation acreage required by mitigation scenario and flood protection alternative for each mitigation strategy.

Acres required to mitigate impacts using the in-kind mitigation goal		
Mitigation strategy	***Channel Improvement Plan***	***Levee Plan***
Acquisition	31,293.9	5,112
Restoration	3,205.2	1,282
Regeneration	1,619.33	916
Acres required to mitigate impacts using the equal replacement mitigation goal		
Mitigation strategy	***Channel Improvement Plan***	***Levee Plan***
Acquisition	17,190	2,250
Restoration	9,076	1,836

Regeneration	5,850	1,950

A mitigation plan has been developed but because the exact mitigation site has not been identified the mitigation scenarios presented lack specificity that would allow the Service to determine the overall adequacy of those scenarios; development of a detailed plan should be coordinated with the Service. Inclusion of the following components with applicable details in the plan should aid the Service in determining the likelihood of mitigation success, as well as aid the District in achieving compliance with Section 2036(a) of the WRDA 2007:

1) criteria for determining ecological success;
2) monitoring until after successful completion;
3) a description of available lands for mitigation and the basis for the determination of availability;
4) development of a contingency plan (i.e., adaptive management);
5) identification of the entity responsible for monitoring; and
6) establish a consultation process with appropriate Federal and State agencies to determine acceptable means of mitigation and success criteria.

FISH AND WILDLIFE CONSERVATION MEASURES

By choosing Alternative C (channel improvement plan), the District has selected the most environmentally damaging alternative. Since there are unavoidable losses of wildlife resources associated with this alternative, habitat compensation is appropriate. The proposed project would replace approximately 9.5 miles of riverine habitat of varying habitat quality (i.e., 6 miles of channelized areas and riparian cleared areas and the remainder relatively natural areas) with a lentic environment. Lentic conditions are estimated to predominate the area for approximately six months (i.e., low flow conditions). Some riverine habitat dependent species, including some at-risk species, would not be able to maintain their current population levels and will decline. Impacts to federally listed species have been addressed via ESA section 7 consultation. Mitigation efforts that restore in-stream functions elsewhere within the range of the at-risk species could offset expected habitat loss to those resources. River restoration concepts have been developed by Kennedy and Hasse (2009), LDWF, and ERDC and should be examined in coordination with natural resource agencies. Since six of the seven at-risk species are not found north of the Ross Barnett Reservoir, mitigation efforts should be first focused south of the Reservoir if they are to help ensure the conservation of those species. Mitigation efforts on the main-stem of the Pearl River should be considered the highest priority, with secondary priority given to larger Pearl River tributaries (e.g., Strong River).

Fish passage at the proposed weir would provide benefits to the southeastern blue sucker, American shad, and American eel. However, fish usage of passage structures is not a guarantee; therefore, the success of such measures should be addressed through monitoring and adaptive management.

Riparian protection via land acquisition or conservation easements could provide benefits to all at-risk species through removal of threats associated with sedimentation and riparian forest loss.

Removing threats associated with channel clearing/desnagging and target shooting by the public could also provide benefits to the Pearl River map turtle and other riverine turtles.

The riverine sandbar habitat, especially the less modified sites located outside of the channelized areas, that would be impacted by the proposed project has high wildlife resource values and is becoming relatively scarce on a regional and national basis. The Service's mitigation goal for this habitat type is no net loss of in-kind habitat value. Measures to avoid and minimize impacts should be developed and implemented. Mitigation measures could also include implementation of some of the recovery criteria for the threatened ringed map turtle and should explore the inclusion of measures to help protect and restore habitat for the at-risk Pearl River map turtle, another species endemic to the Pearl River Basin.

Where the Pearl River and tributary stream water levels will be increased or decreased by project implementation, the District should analyze the potential extent of resulting channel re-adjustment or other hydrogeomorphic changes (e.g., bank erosion, channel incision) and implement mitigation measures, such as in-stream structures, to ameliorate negative impacts to stream habitat and benthic and aquatic fauna. Impacts resulting from tributary channel re-adjustment and proposed mitigation should be quantified and included in the impact and mitigation analysis including increased sedimentation and loss of riparian habitat.

Gate operations at reservoirs have been used to help flush sediment captured within pools downstream (Fruchard and Camenen 2012; Espa et al. 2013); therefore, development of an operational plan to aid sediment flushing should be undertaken.

The potential for reduced flows during droughts and the resulting impacts to downstream aquatic resources is a concern that has not been quantified based on such occurrences. Reduced flows could result in poor water quality conditions from downstream discharges further impacting aquatic resources.

The Service recommends compensatory mitigation on lands with the same ownership classification as the lands where impacts occurred; therefore, mitigation plans should incorporate a public land measure for any impacts to public lands.

Release of contaminants during construction and pool filling, and their impact on fish and wildlife resources is a concern that should be addressed via the development of a contaminant investigation and report on methods of addressing that potential issue.

Because a mitigation site has not been selected the proposed mitigation scenarios lack specificity that would allow the Service to determine the overall adequacy of those scenarios. Inclusion of the additional detailed components in the plan should aid the Service in determining the likelihood of mitigation success.

Variations of the weir height or amount and/or extent of excavation needed to achieve project purposes was not presented. Such weir modifications could have the potential to reduce impacts while still maintaining a high degree of flood risk reduction.

Alteration of the Pearl River Basins' floodplain has contributed to the decline in the overall function and values of the Pearl River as evidenced by the increase of loss or decline of riverine dependent species, including some at-risk species, within the watershed and the loss of species diversity. Therefore, the District with other water resource development agencies should include an additional planning objective to address this basin-wide problem.

Levee Plan Alternative and Service modifications

Alternative B (levee plan) provides flood protection with fewer impacts to fish and wildlife resources, especially listed and at-risk species. However, the Service advises that Alternative B should include further modification (including additional flood reduction features) to aid in achieving additional flood control while avoiding and minimizing impacts to fish and wildlife resources and their habitats, including major modification to the Pearl River and its floodplain.

Widening of the floodplain via levee setbacks would restore some wetland functions to isolated wetlands and has the potential to reduce flood stages. Reducing or removal of flow impediments and elevated topography within the floodplain could contribute to lower flood stages. Implementing additional conveyance improvements at flow impediments may also further reduce flood stage elevations. All of these actions would result in impacts to fish and wildlife resources, however, riverine habitat, though altered, would continue to exist within the project area.

RECOMMENDATIONS

The Service provides the following recommendations for Alternatives C (the TSP) and B (levee plan); consideration of each recommendation should be undertaken to ensure compliance with the equal consideration clause of the FWCA. The recommendations for Alternative B would also apply to that alternative even if the Service's proposed modifications are incorporated.

For the Channel Improvement Alternative (TSP):

1. Ensure that the least damaging alternative has been selected.

2. Mitigation should be implemented concurrent with construction.

3. Mitigation for unavoidable losses of fish and wildlife habitat, as reflected by loss of Average Annual Habitat Units (AAHUs) should be done within the Pearl River Basin. Detailed mitigation plans should be developed and coordinated with the natural resource agencies. At minimum the plan components should include:
    a. criteria for determining ecological success ;
    b. monitoring until after successful completion;
    c. a description of available lands for mitigation and the basis for the determination of availability;
    d. identification of the entity responsible for monitoring;
    e. development of a contingency plan (i.e., adaptive management); and
    f. establish a consultation process with appropriate Federal and State agencies to determine acceptable means of mitigation and success criteria.

4. During low-flow periods, including droughts, a minimum flow of 170 cubic feet per second should be maintained even if water levels fall below target pool elevations, matching the discharge from the Ross Barnett Reservoir. At all other times the flow should discharge sufficient water to meet the needs of the Savanna Street Wastewater Treatment Facility (i.e., 225 cubic feet per second).

5. When filling the pool, the downstream flow should at least maintain the minimum required discharge from the Ross Barnett Reservoir, while also allowing portions of flood flows to pass downstream.

6. Mitigation for riparian, sand bar, and riverine impacts should be combined to help achieve some cost-effectiveness. Selection of mitigation sites and development of mitigation plans should be done in coordination with the natural resource agencies. During consideration of mitigation sites, recovery goals for threatened species within the project area should be considered as well as habitat that would help conserve at-risk species. Location of mitigation areas downstream of the project area would aid in the conservation of at-risk species; however, mitigation upstream of the Ross Barnett Reservoir is acceptable. Other additional mitigation features that could be considered include riverbank protection/stabilization in areas that are experiencing instability, gravel bar protection/restoration, sand and gravel mine restoration, and sill removal.

7. Long-term water quality and quantity monitoring up and down stream and within the expanded channel should be undertaken pre- and post-construction. Measured parameters should include at minimum temperature, dissolved oxygen (DO), total suspended sediments, nitrogen, pH, fecal coliforms, velocity, discharge, and water levels, as well as other physical and chemical parameters necessary to maintain the life cycle of selected aquatic species. This water quality-monitoring plan should be developed in cooperation with the natural resource agencies and should be used to ensure aquatic AAHUs mitigated by the pool are achieved. This would aid in complying with ER 1110-2-8154; engineer regulation on water quality.

8. In consultation with the natural resource agencies, a plan should be developed to identify and designate shoreline usage areas within the project area, as well as down and upstream areas influenced by the project. Designations should include: 1) limited development, 2) public recreation, 3) protected shoreline, and 4) prohibited access areas (e.g., public safety). This would help ensure that fish and wildlife mitigation, including minimization, associated with the project are maintained and would aid in complying with ER 1110-2-8154.

9. Sediment testing for contaminants is recommended in areas proposed for use as borrow or that would be flooded by the project, especially those around known contaminated areas that are proposed for use in levees, berms, or islands, where contaminant exposure to fish and wildlife is probable. The testing and response plan for any contaminated soil should be developed in cooperation with the natural resource agencies.

10. To minimize adverse impacts to migratory fish species the design of the fish passage should be coordinated with the natural resource agencies.

11. Development of an operational plan to aid sediment flushing.

12. A monitoring and adaptive management plan addressing upstream and downstream geomorphology impacts should be developed to determine the need to implement grade or other erosion control (e.g., bank stabilization, etc.) features to minimize project impacts to the Pearl River and its tributaries. That plan should include at minimum the use of aerial photographs, geographical information systems, gauge and cross-section data, as well as other parameters deemed necessary during development of that plan. The plan should be developed in cooperation with the natural resource agencies. Monitoring may result in the determination of additional monitoring and/or mitigation needs from such impacts; the plan should incorporate a request for pre-authorization for such mitigation in the event that it is determined necessary.

13. An invertebrate and fishery monitoring plan should be developed to ensure that all impacts to the project have been mitigated and that mitigation features (e.g., river restoration, etc.) are functioning as intended. This long-term plan should incorporate various gear types (e.g., electro-shocking, seines, gill nets, etc.) to maximize the detection of various riverine guild species most susceptible to water resource development projects and should be cost-shared as a project feature. That plan should be developed in cooperation with the natural resource agencies.

14. Creation and reforestation of a riparian zone along the toe of the levee, especially adjacent to the created sand bars should be undertaken where feasible to provide riparian habitat and provide erosion protection to the fill areas. To provide erosion protection the width would need to be approximately 300 feet; this would be advantageous to wildlife as well but narrower widths could also provide useable wildlife habitat.

15. Impacts to the public lands, such as LeFleur's Bluff State Park, and other conservation lands (Fannye Cook Natural Area) should be avoided and minimized. Mitigation for such impacts should be located on public lands or property that is placed into the public trust.

16. A conservation easement, in perpetuity, should be recorded on the deed of any mitigation site.

17. Incorporate sediment and erosion control measures during construction and re-vegetate all disturbed areas immediately following construction.

18. In order to ascertain the validity of the HEP analysis the Service requests that an inter-agency review be conducted of the assumptions by target years and suitability indices; such reviews can ensure the proper application of models and the calculation of impacts and mitigation.

19. The Engineering Research and Development Center (ERDC) previously assessed impacts to lacustrine, backwater, and riverine species and habitats separately (Appendix C in the Environmental Appendix, i.e., Appendix D) and formulated separate riverine impacts and mitigation concepts. The Service endorses and supports the mitigation and impact analysis approach and the mitigation measures for Alternative C to ensure riverine habitat impacts are fully mitigated.

20. A comprehensive assessment of changes in the Pearl River Basin's hydrology and land uses should be conducted to determine their influence on flooding and the ecosystem response with a goal of identifying and developing ecosystem restoration projects that can reduce flood risk throughout the Basin.

21. The Service and other natural resource agencies should be coordinated with during the next planning and construction phases as project details are developed.

22. LDWF has concerns regarding the loss of any flows and the resulting potential changes to water quality, especially salinities, within the northwestern portion of the Mississippi Sound. Therefore, they recommend a water quality station be established at Half Moon Island. Details regarding water quality parameters and location should be developed with the LDWF Marine Fisheries staff.

<u>For Alternative B with Service proposed modifications</u>:

1. Mitigation for unavoidable losses of fish and wildlife habitat, as reflected by loss of Average Annual Habitat Units (AAHUs) should be done within the Pearl River Basin. Detailed mitigation plans should be developed and coordinated with the natural resource agencies. At minimum, the plan components should include:
    a. monitoring until after successful completion;
    b. criteria for determining ecological success;
    c. a description of available lands for mitigation and the basis for the determination of availability;
    d. identification of the entity responsible for monitoring;
    e. development of a contingency plan (i.e., adaptive management); and
    f. establish a consultation process with appropriate Federal and State agencies to determine acceptable means of mitigation and success criteria.

2. Borrow pits should be designed to improve fish and wildlife habitat and to enhance recreational opportunities as described in the USACE 1986 report entitled, "Environmental design considerations for main stem levee borrow areas along the lower Mississippi River."

3. Incorporate sediment and erosion control measures during construction of the levees and re-vegetate all disturbed areas immediately following construction.

4. Monitor sandbars in the Pearl River upstream, and downstream of the project area to determine net changes in size and availability of sand bar habitat as affected by changes in river hydrology. Details of this monitoring effort, including duration, should be

coordinated with the natural resource agencies and should include remote sensing, field inspection/surveys, and river gauge data.

5. Continue the limited use of herbicides in the maintenance of the overbank and floodway cleared areas.

6. Limit the removal of vegetation in the project area to that necessary for the construction and maintenance of project flood control features.

7. Restrictive use zoning or non-development easements should be implemented by the local sponsor, prior to project construction, and contain language stringent enough to ensure that flood-prone development does not occur and that undeveloped lands in the floodplain are used for floodwater storage, wildlife, outdoor recreation, and other flood compatible land uses.

8. A conservation easement, in perpetuity, should be recorded on the deed of any mitigation site.

9. Levee setbacks, as proposed for Alternative C, are recommended to widen the floodplain and reduce flood stage elevations.

10. Excavation of the cleared floodplain to a lower elevation that would reduce water surface elevations while still allowing maintenance mowing is proposed. This could also be implemented in other areas where passage of flows is restricted, floodplain features prevent a more lateral dispersal of flood waters, or topography reduces the floodplain capacity. This should lower flood stages within these areas. Excavated soils, if suitable, should be used in levee construction. Floodplain excavation could also include removal of the floodplain portion of the Gallatin Street landfill near RM 285, a site identified in the draft FS/EIS that could be leaching chemicals into the groundwater and potentially into the Pearl River and its floodplain.

11. Conveyance improvements could be implemented around transportation embankments and lowering of the floodplain elevation in those areas could also be done.

12. If needed, additional borrow material could be taken from within the cleared floodplain but those sites should be located where they will not become permanently connected to the river.

13. The Service and other natural resource agencies should be coordinated with during the next planning and construction phases as project details are developed.

SUMMARY OF FINDINGS AND SERVICE POSITION

The Service Mitigation Policy (Federal Register, Vol. 46, pp. 7644-7663, January 23, 1981) is specific in its guidance pertaining to formulation of an official position relative to a given water development project. In essence, a project must meet the five criteria presented below in order to gain Service approval.

1) Proposals are ecologically sound.
2) The least environmentally damaging reasonable alternative is selected.
3) Every reasonable effort is made to avoid or minimize damage or loss of fish and wildlife resources and uses.
4) All important recommended means and measures have been adopted with guaranteed implementation to satisfactorily compensate for unavoidable damage or loss consistent with the appropriate mitigation goal.
5) For wetlands and shallow water habitats, the proposed activity is clearly water dependent and there is a demonstrated public need.

The Mitigation Policy also provides explicit guidance regarding formulation of the Service position regarding a given project:

> "The Service may recommend the 'no project' alternative for those projects or other proposals that do not meet all of the above criteria and where there is likely to be a significant fish and wildlife resource loss."

The Service is not opposed to providing flood protection to Jackson and the surrounding area; however, in accordance with the above provisions, the Service currently has concerns regarding implementation of the Tentatively Selected Plan as proposed in the Pearl River Basin, Mississippi, Federal Flood Risk Management Project, Rankin and Hinds Counties, Mississippi Project. The reasons for our concerns, which address the five criteria presented above, are provided below:

1. As currently proposed the weir would impede aquatic species movement for an additional 18 miles upstream and would convert approximately 9.5 miles of riverine habitat to lacustrine habitat for approximately six months of each year. Some at-risk species and other aquatic species that are more dependent on riverine habitat would no longer persist at current population levels due to that habitat conversion. A fish passage would mitigate impacts of the weir but monitoring and adaptive management would be warranted.

2. The TSP is the most damaging alternative for both terrestrial and aquatic resources. The Service's proposed modifications to Alternative B could provide flood protection with reduced impacts to terrestrial and aquatic resources, however, the actual flood risk reduction benefits are not known because the array of alternatives did not feature such combinations. Variations of the TSP (e.g., weir heights, amount and/or extent of excavation) are not presented within planning documents.

3. The Service has provided recommendations within the draft and final FWCA reports that would aid in avoiding and minimizing impacts to fish and wildlife resources and uses. Incorporation of those recommendations would aid in complying with this criterion. Various flood risk reduction features were proposed in several of the alternatives however, incorporation of those alternatives into the final array of alternatives was not

examined. Variations of the TSP that may have reduced impacts to fish and wildlife resources were not presented in the planning documents. The Service's proposed modifications to Alternative B represent a potentially feasible alternative to achieve avoidance and minimization while still meeting the project goals. The lack of specificity within the mitigation plan precludes the Service from determining if the proposed mitigation would fully compensate fish and wildlife losses, however, the Service understands additional mitigation planning is ongoing.

4. Within the USACE planning process typically teams are developed to guide that process. As this study was not conducted in that manner, the Service was not fully involved and able to provide recommendations and conservation measures that could have been adopted early in the planning process. The Service did participate in meetings and was engaged via discussions throughout the later part of the planning process (i.e., a preliminary draft EIS was already prepared). Addressing the above Service recommendations within the final FS/EIS should assist in complying with this criterion.

5. There is a demonstrated need for flood protection within the Jackson area; however, the need for the proposed Channel Improvement Plan in-lieu of other possible flood control alternatives that maybe less damaging has not been clearly demonstrated.

If Alternative C is selected for implementation, the Service requests that all of our recommendations be incorporated into the project plans to ensure compliance with the FWCA. The Service looks forward to our continued work with the District to address the flood risk reduction needs of Jackson and the surrounding area.

LITERATURE CITED

Allen, S. B., J. Dwyer, D. Wallace, and E. Cook. 2003. Missouri River flood of 1993: role of woody corridor width in levee protection. Journal of American Water Resources Association 39(4):923-933.

Baker, J.A., K.J. Killgore, and R.L. Kasul. 1991. Aquatic habitats and fish communities in the lower Mississippi River. Aquatic Sciences 3(4): 313-356.

Bennet, M.G., B.R. Kuhajda, and J.H. Howell. 2008. Status of the imperiled frecklebelly madtom, *Noturus munitus* (Siluriformes: Ictaluridae). Southern Naturalist 7(3): 459-474. https://www.jstor.org/stable/20204015?seq=1#metadata_info_tab_contents

Benstead, J.P., J.G. March, C.M. Pringle, and F. N. Scatena. 1999. Effects of a low-head dam and water abstraction on migratory tropical stream biota. Ecological Applications, Vol. 9, No. 2: 656-668. https://www.jstor.org/stable/2641152

Berry, G. 2019. The Ecology and Evolution of the Freshwater Turtles of Southern Mississippi. Master's Theses. University of Southern Mississippi. 176 pp. https://aquila.usm.edu/masters_theses/666

Butts, T.A., and R. L. Evans. 1978. Effects of channel dams on dissolved oxygen concentrations in northeastern Illinois streams. Illinois State Water Survey; Circular 132. ISWS/CIR-132/78. 36 pp.

Camack, D., and K. Piller. 2018. Going with the flow: testing the role of habitat isolation among three ecological divergent darter species. http://www.bioone.org/doi/full/10.1643/CG-17-623

Clark, S., W. Slack, B. Kreiser, J. Schaefer, and M. Dugo. 2008. Stability, persistence, and habitat associations of the pearl darter *Percina aurora* in the Pascagoula River System, southeastern USA. Endangered Species Research 36: 99-109.

Crider, A.F. 1906. Geology and mineral resources of Mississippi. U.S. Department of Interior, U.S. Geological Survey. 93 pp.

Csiki, S.J.C. 2014. The impact of run-of-river dams on channel morphology and sedimentation. Master’s Dissertation. University of Illinois at Urbana-Champaign, Urbana Illinois. 272 pp.

Csiki, S. and B. Rhoads. 2010. Hydraulic and geomorphological effects of run-of-river dams. Progress in Physical Geography. 34(6): 755- 780.

Cumming, G.S. 2004. The impact of low-head dams on fish-species richness in Wisconsin, USA. Ecological Applications 14(5): 1495-1506. https://www.jstor.org/stable/20204015

Dean, J.D., Eds. D. Gillette, J. Howard, S. Sherraden and J. Tiemann. 2002. Effects of low-head dams on freshwater mussels in the Nesho River, Kansas. Transactions of the Kansas Academy of Science 106(3-4): 232-240.

Dwyer, J.P., D. Wallace, and D. Larsen. 1997. Value of woody river corridors in levee protection along the Missouri River in 1993. Journal of American Water Resources Association 33(2)481-489.

Early, T.M. 2016. Modeling the variable effects of low-head dams on freshwater mussel assemblages. Honors Thesis Appalachian State University. 48 pp.

Environmental Protection Agency (EPA). 1975. Report on Ross Barnett Reservoir, Jackson, Madison, and Rankin Counties, Mississippi. Region IV, Working Paper 362. 13 pp.

Espa, P., E. Castelli, G. Crosa, and G. Gentili. Environmental effects of storage practices: controlled flushing of fine sediment from a small hydropower reservoir. Environmental Management 52: 261-276.

Federal Interagency Stream Restoration Working Group. 1998. FISRWG (10/1998). Stream Corridor Restoration: Principles, Processes, and Practices. (FISRWG)(15 Federal agencies of the US government). GPO Item No. 0120-A; SuDocs No. A 57.6/2:EN 3/PT.653. ISBN-0-934213-59-3. https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/water/manage/restoration/?cid=stelprdb1043244

Fencl, J.S., M.E. Mather, J.M. Smith, and S.M. Hitchman. 2017. The blind men and the elephant examine biodiversity at low-head dams: are we all dealing with the same dam reality? Ecosphere Vol8(11): 1-17. www.esajournals.org.

Fruget, J.F. 1992. Ecology of the lower Rhone after 200 years of human influence: a review. Regulated Rivers: Research and Management, Vol. 7, No. 3: 233-246.

Fruchard, F., and B. Camenen. 2012. Reservoir sedimentation: different type of flushing – friendly flushing example of genissiat dam flushing. ICOLD Symposium on Dams for a changing world, June 2012, Kyoto, Japan. 6 pp. https://hal.archives-ouvertes.fr/hal-00761305

Galbraith, H.S., Blakeslee, C.J., Cole, J.C., and Silldorff, E.L., 2018, Freshwater mussel survey for the Columbia Dam removal, Paulins Kill, New Jersey: U.S. Geological Survey Open-File Report 2018–1074, 7 p., https://doi.org/10.3133/ofr20181074.

Gangloff, M.M., E.E. Hartfield, D.C. Werneke, and J.W. Feminella. 2011. Associations between dams and mollusk assemblages in Alabama streams. Journal of North American Benthological Society 304(4): 1107-1116.

Geyer, W.A., T. Neppl, K.Brooks, and J. Carlisle. 2000. Woody vegetation protects streambank stability during the 1993 flood in central Kansas. Journal of Soil and Water Conservation 55(4): 483-486.

Gosselink, J.G., C.E. Sasser, L.A. Creasmar, S.C. Hamilton, E.M. Swenson, and G.P. Shaffer. 1989. Draft cumulative impact assessment in the Pearl River basin, Mississippi and Louisiana. 248 pp.

Haponski, A.E., T.A. Marth, and C.A. Stepien. 2007. Genetic divergence across a low-head dam: a preliminary analysis using logperch and greenside darters. Journal of Great Lakes Research 33 (Special Issue2): 117-126. https://www.jstor.org/stable/2641152

Hasse, C.S. 2006. Hydrologic analysis of the Pearl River between Edinburg, MS, and Bogalusa, LA. The Nature Conservancy, Southern United States Region. 39 pp.

Helms, B.S., D.C. Werneke, M.M. Gangloff, E.E. Hartfield, and J.W. Feminella. 2011. The influence of low-head dams on fish assemblages in streams across Alabama. Journal of North American Benthological Society 304(4): 1095-1106. http://www.bioone.org/doi/full/10.1899/10-093.1.

Jones, R. and W. Selman. 2009. *Graptemys oculifera* (Baur 1890) - Ringed Map Turtle, Ringed Sawback. Conservation Biology of Freshwater Turtles and Tortoises. *Chelonian Research Monographs, No.* 5.

Kennedy, T.P., and C.S. Hasse. 2009. Geomorphic and sediment assessment of the Pearl River in Mississippi and Louisiana. The Nature Conservancy. 128 pp.

Klimas, C. 1998. Forested buffers for overbank flow velocity reduction along the lower Mississippi River. Proceedings of the National Wetland Symposium: Wetland hydrology. September 16-18, 1987: 152-155.

Lang, J.W. 1972. Geohydrologic summary of the Pear River Basin, Mississippi and Louisiana. Geological Survey Water-Supply Paper 1899-M. 53 pp.

Lee, F.N. 1985. Analysis of the low-flow characteristics of streams in Louisiana. Water Resources Technical Report No. 35. Published by Louisiana Department of Transportation and Development. 53 pp.

Mississippi Department of Wildlife, Fisheries and Parks (MDWFP). 2014. Endangered Species of Mississippi. Mississippi Department of Wildlife, Fisheries and Parks, Jackson, MS. 199 pp.

Mississippi Department of Wildlife, Fisheries and Parks (MDWFP). 2016. Mississippi State Wildlife Action Plan 2015 – 2025. Mississippi Department of Wildlife, Fisheries and Parks, Jackson, MS. 704 pp.

Monroe, W.H. 1954. Geology of the Jackson area, Mississippi. Stratigraphic and structural study of the area surrounding the Jackson gas field. Geological Survey, Bulletin 986. 131 pp.

Odum, E.P. 1978. Ecological importance of the riparian zone. Pp. 2-4 *in* Johnson, R.R. et al. (eds.). Strategies for protection and management of floodplain wetlands and other riparian ecosystems. USDA Forest Service. GTR-WO-12.

Oswalt, Sonja N. 2015. Mississippi's forests, 2013. Resour. Bull. SRS–204. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station. 81 p.

Piller, K.R., H.L. Bart, Jr., and J.A. Tipton. 2004. Decline of frecklebelly madton in the Pearl River based on contemporary and historical surveys. Transactions of the American Fisheries Society 133: 1004-1013.

Pearson, A.J., J.E. Pizzuto, and R. Vargas. 2016. Influence of run of river dams on floodplain sediments and carbon dynamics. Geoderma 272: 51-63. www.elsevier.com/locate/geoderma.

Phalen, P.S., R.J. Muncy, and T.K. Cross. 1988. Hybrid striped bass movements and habitat in Ross Barnett Reservoir, Mississipp. Procedures of the Annual Conference of the Southeast Association of Fish and Wildlife Agencies 42: 35-43.

https://www.mdeq.ms.gov/wp-content/uploads/2004/01/PearlRBConehomaYockPCBJan04.pdf.

https://www.mdeq.ms.gov/wp-content/uploads/2017/06/2014_305b_final.pdf.

Robinson, S.K., F.R. Thompson III, T.M. Donovan, D.R. Whitehead, and J. Faaborg. 1995. Regional forest fragmentation and the nesting success of migratory birds. Science 267: 1987–1990.

Roghair, C., J. Moran, S. Adams, W. Haag, M. Warren, C. Krause, and C. Dolloff. 2016. Examination of fish, crayfish, mussels and habitat in transitional reaches upstream of Lewis Smith Reservoir, Alabama. 50 pp.

Santucci, V.J., Jr., S.R. Gephard, and S.M. Pescitelli. 2005. Effects of multiple low-head dams on fish, macroinvertebrates, habitat and water quality in the Fox River, Illinois. N. American Journal of Fisheries Management. 25:975-992.

Selman, W. 2018. Diamonds in the rough: status of two imperiled *Graptemys* species (*Graptemys oculifera* and *G. peralensis*) in the Pearl River of Jackson, MS. 39 pp.

Skalak, K., J. Pizzuto, and D.D. Hart. 2009. Influence of small dams on downstream channel characteristics in Pennsylvania and Maryland: implications for the long-term geomorphic effects of dam removal. Journal of the American Water Resources Association. Vol. 45, No. 1: 97-109.

Smith, S.C.F., S.J. Meiners, R.P. Hastings, T. Thomas, and R.E. Colombo. 2017. Low-head dams impacts on habitat and the functional composition of fish communities. River Research and Applications 33: 680-689.

Stauffer, D.F., and L.B. Best. 1980. Habitat selection by birds of riparian communities: evaluating effects of habitat alterations. Journal of Wildlife Management 44(1): 1-15.

Tiemann, J.S., S.A. Douglass, A.P. Stodola, and K.S. Cummings. 2016. Effects of low-head dams on freshwater mussels in the Vermilion River Basin, Illinois, with comments on a natural dam removal. Transactions of the Illinois State Academy of Science. Vol. 109: 1-7.

Tipton, J., H. Bart, Jr., and K. Piller. 2004. Geomorphic disturbance and its impact on darter (Teleostomi: Percidae) distribution and abundance in the Pearl River drainage, Mississippi. Hydorbiologia 527: 49-61.

U.S. Army Corps of Engineers (USACE). 1981. Pearl River basin reconnaissance report. Corps of Engineers, Mobile, Alabama. 127 pp. plus appendices.

U.S. Army Corps of Engineers (USACE). 1984 (revised 1985). Pearl River basin interim report on flood control and environmental impact statement. Corps of Engineers, Mobile, Alabama. 123 pp. plus appendices. (COESAM/PD-A-84-002).

U.S. Army Corps of Engineers (USACE). 1986. Environmental design considerations for main stem levee borrow areas along the Mississippi River. Report 4. Corps of Engineers, Vicksburg, Mississippi. 28 pp.

U.S. Army Corps of Engineers (USACE). 1994. Habitat evaluation procedures (HEP) analysis on the Jackson metro flood control project. Corps of Engineers, Vicksburg, Mississippi. 17 pp.

U.S. Fish and Wildlife Service (Service). 1980a. Habitat as a basis for environmental assessment. 101 ESM, USDI, Fish and Wildlife Service, Washington, D.C.

U.S. Fish and Wildlife Service (Service). 1980b. Habitat evaluation procedures (HEP). 102 ESM, USDI, Fish and Wildlife Service, Washington, D.C.

U.S. Fish and Wildlife Service (Service). 1984. Four point plan, Pearl River flood control study. USDI, Fish and Wildlife Service, Ecological Services, Daphne, Alabama. 57 pp. plus appendices.

U.S. Fish and Wildlife Service (Service). 1985. Pearl River basin interim report on flood control. USDI, Fish and Wildlife Service, Ecological Services, Daphne, Alabama. 51 pp. plus appendices.

Weiland, R.. 2000. Ecology and vegetation of LaFleur's Bluff State Park, Jackson, Mississippi. Journal of the Mississippi Academy of Sciences. Vol. 45, No. 3: 150-185.

Whitley, J.R., and R.S. Campbell. 1974. Some aspects of water quality and biology of the Missouri River. Transactions of the Missouri Academy of Science (7-8): 61-72.

Wilson, K.V., Jr., and M.N. Landers. 1991. Annual peak stages and discharges for streamflow-gaging stations in Mississippi. U.S. Geological Survey. Water-Resources Investigation Report 91-4098. 709 pp.