Mississippi Valley Division,
Regional Planning and Environment Division South

Pearl River Basin, Mississippi, Federal Flood Risk Management Project

Appendix J - Fish and Wildlife Coordination Act Report

June 2024

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United States Department of the Interior

FISH AND WILDLIFE SERVICE
Mississippi Ecological Services Field Office
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Jackson, Mississippi 39213
Phone: (601)965-4900

August 23, 2023

Colonel Christopher Klein
Vicksburg District Commander
U.S. Army Corps of Engineers
4155 Clay Street
Vicksburg, Mississippi 39183-3435

Dear Colonel Klein:

Enclosed is our draft Fish and Wildlife Coordination Act (FWCA) (48 Stat. 401, as amended; 16 U.S.C. 661-667e) report for the Pearl River Basin, Mississippi Federal Flood Risk Management Project, Hinds and Rankin Counties, Mississippi. This is presented in partial fulfillment of FWCA and does not constitute the final report of the Secretary of the Interior as required by Section 2(b) of the FWCA. We consider this partial fulfillment due to inadequate time permitted to fully analyze impacts and determine proper mitigation measures for loss in riverine function and habitat for each alternative. The U.S. Fish and Wildlife Service (Service) received the draft Hydrologic and Hydraulic Model and the description of updated alternatives on July 26, 2023, with our report expected on August 1, 2023, which does not provide sufficient time to analyze impacts from the proposed alternatives nor the mitigation plan. These time constraints necessitate the use of previous analyses to determine impacts and resulting compensatory mitigation requirements to the extent possible. Additional time is needed to determine if the previous impact analysis was sufficient and accurate in identifying appropriate mitigation for impacts. Compensatory mitigation plans are ongoing, and specific tasks may not be available until after the Corps has completed a draft EIS. The Service continues to support ongoing coordination and planning for mitigation.

The Service requests any updated data and information from the downstream analysis that was conducted by the Corps. We also request time to accurately analyze impacts from the project and carefully evaluate mitigation plans, the proposed mitigation sites, and proposed success criteria. Finally, we request information, plan details, and impact analysis regarding any alternatives that may be considered and have not yet been fully described (i.e., the "combination thereof" alternative). Assessing impacts to projects lacking full details and potential impacts is difficult. Our comments that were submitted in response to the Corps' Notice of Intent (June 2023) are included in this report.

The project proposes flood control measures along the Pearl River, providing economic and flood control benefits for the Jackson metropolitan area. Although several alternatives have been identified, three were provided to the Service, Alternative A1 – combination of nonstructural solutions, Alternative C – channel improvements with construction of a large weir, and any combination thereof (CTO). Our draft report presents expected ecological impacts, recommendations to avoid or minimize those impacts, conservation measures, and proposed mitigation measures for these alternatives.

It remains our position that Alternative C continues to be the most ecologically damaging alternative. The Service continues to advocate for a plan that balances the needs of fish, wildlife, and wetland resources alongside the need to provide flood control for the Jackson Metropolitan Area. In particular, we favor a plan that achieves flood control without the construction of a large weir or impoundment, thus protecting important riverine functions and habitats.

We appreciate the opportunity to provide our draft FWCA Report on the Pearl River Basin, Mississippi Federal Flood Risk Management Project. If you have any questions or require additional information, please contact our POC for this project, Tamara Campbell (601-321-1138).

Sincerely,

JAMES AUSTIN

Digitally signed by JAMES AUSTIN
Date: 2023.08.23 14:18:47 -05'00'

James Austin
Field Supervisor
Mississippi Field Office

cc: Environmental Protection Agency, Atlanta, GA
Mississippi Department of Wildlife, Fisheries, and Parks
Mississippi Department of Marine Resources
USFWS, Ecological Services, Louisiana Field Office
Louisiana Department of Wildlife and Fisheries

Fish and Wildlife Coordination Act Report

Pearl River Basin, Mississippi Federal Flood Risk Management Project

Prepared by: Tamara Campbell
U.S. Fish and Wildlife Service
Ecological Services
Jackson, Mississippi
July 2023

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Introduction

The U.S. Fish and Wildlife Service (Service) has prepared this draft Fish and Wildlife Coordination Act (FWCA) (48 Stat. 401, as amended; 16 U.S.C. 661-667e) report for the Pearl River Basin, Mississippi Federal Flood Risk Management Project (Project), Hinds and Rankin Counties, Mississippi. This Act requires that the U.S. Army Corps of Engineers (Corps) coordinate with the Service to ensure that wildlife conservation be given equal consideration alongside other features of water-resource development programs through planning, development, maintenance and coordination of wildlife conservation and rehabilitation. This report is presented in partial fulfillment of FWCA and does not constitute the final report of the Secretary of the Interior as required by Section 2(b) of the FWCA. Due to insufficient data and time to adequately analyze alternatives, impacts, and mitigation plans, the Service requests further coordination to complete final FWCA obligations.

The purpose of the Project is to provide economic and flood control benefits for the Jackson metropolitan area. The U.S. Army Corps of Engineers (Corps) is preparing a draft environmental impact statement to analyze flood risk management plans that can be implemented under section 3104 of the Water Resources Development Act of 2007. The Corps plans to identify a national economic development (NED) plan and compare it to other alternatives, one of which was presented in an earlier study, Alternative C, and two new Corps alternatives (Alternative A1 – nonstructural solutions, and Combination/Hybrid Plan (CTO)). They plan to assess the environmental acceptability and technical feasibility of the alternatives; and provide the Secretary of the Army the information necessary to choose a plan. Downstream impacts to the Pearl River Basin will also be assessed.

Because of the high habitat diversity, the complexity of hydrological relationships to ecosystem structure and function, and some structural modification to the system, numerous studies, reports, and data sources were available to develop and evaluate recommendations for the Pearl River. In previous assessments of flood control alternatives, the Service concluded that Alternative C (channel improvements, widening, and construction of a large weir) was the most ecologically damaging of those presented. This evaluation is based on current data and analysis available from Corps sources and Service files. Additional Service involvement for subsequent detailed planning, engineering design, and construction phases of each planning effort is required to fulfill our responsibilities under FWCA. Additionally, as pointed out in the Corps' mitigation plan, the Service is concerned that mitigating function and habitat loss of the southeast region's fourth largest river system may be challenging, particularly for permanent adverse impacts related to construction of a large weir or impoundment.

This FWCA report has been provided to the Mississippi Department of Wildlife, Fisheries, and Parks (MDWFP), the Louisiana Department of Wildlife and Fisheries, the Louisiana Ecological Services Field Office, the Environmental Protection Agency, and the Mississippi Department of Marine Resources for comment. Their comments will be incorporated in and attached to the final report as provided. The Service under the authority of FWCA, worked with representatives of the Corps to assess fish and wildlife resources in the area, evaluate alternatives, address issues and objectives, and recommend any preliminary measures for protection and conservation of resources. We will continue to cooperate in ongoing and additional investigations regarding potential impacts, conservation, and mitigation measures.

History

Altered rivers systems generally reduce their natural capacity to retard flood flows, absorb pollutants, anchor soils, reduce sediment loads, and support natural resources. Consequences from ongoing timber and agriculture land-use practices, upstream and tributary alterations, and floodplain encroachment prompted flood control investigations within the Pearl River Basin. Efforts such as the River and Harbor Act of 1945 and the Flood Control Act of 1946 resulted in construction of the Jackson and East Jackson levees, with pumping plants to relieve interior ponding and to promote floodplain development. However, continued floodplain development and constriction has not eliminated flooding issues, as evidenced in the devastating flood of 1979. This cycle of alleviating flood issues, while simultaneously opening the floodplain to more development has potentially exacerbated the issues.

The Ross Barnett Reservoir (RBR) was constructed in the early 1960's, resulting in a 32,000-acre lake that inundated 18 miles of the former river and floodplain. As pointed out in previous Service assessments, the RBR removed the upper one-third of the drainage basin from contributing sediment to the riverine system. Reports indicate that incision and degradation of the Pearl and Strong Rivers were caused by the RBR (Kennedy and Hasse 2009). Such destabilization and degradation led to a decline in aquatic resources (Tipton et al. 2004). Additionally, research revealed 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 (Piller et al. 2004). Further analysis is needed to determine if and how much the system has stabilized.

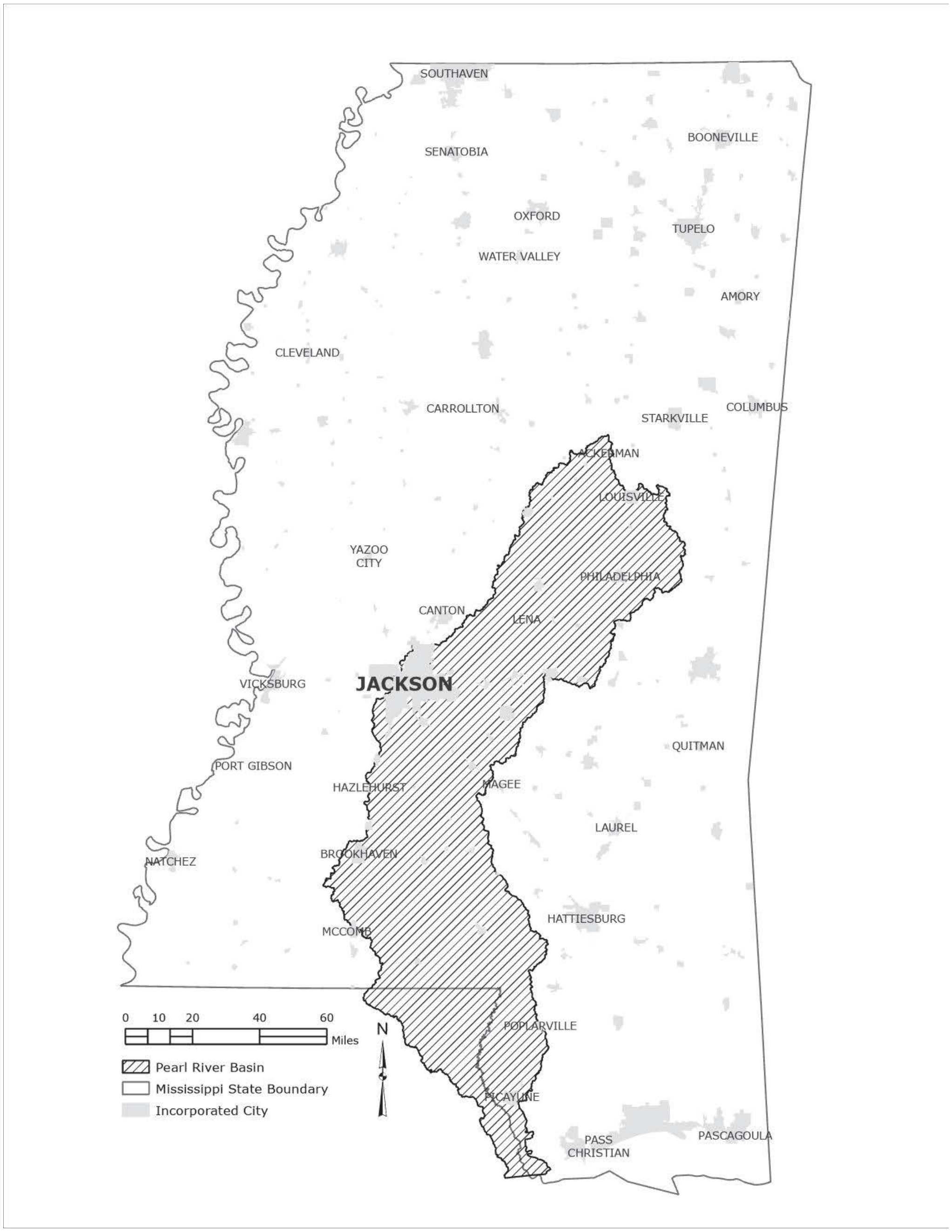
Urban encroachment into the floodplain in the Jackson area necessitated flood control measures that included construction of levees initiated in 1968 along 13.2 miles of the Pearl River. Those flood control measures were inadequate in protecting against the 1979 flood where levees were flanked or nearly overtopped. Since, local entities formulated measures that included a cleared floodway, removal of vegetation and other encroachments, a diversion canal, pumping plants, and expansion of the existing levee and channel system. Further constricting flows or influencing water surface elevation are highways 43, 25, Old Brandon Road, U.S. 80, Interstates 55, 20, and railroad bridges at Jackson Water Works and upstream of highway 80.

In 1983, Congress authorized the Four-Point Plan whose primary component was clearing within the floodway, which occurred in 1984. In 1996, USACE examined the feasibility of constructing additional levees along both sides of the Pearl River to provide flood control to the greater Jackson area. However, no local sponsor agreed to cost-share project implementation. Subsequently, a two-lake plan was also investigated but was determined infeasible.

Description of Study Area

Forming from the confluence of Nanih Waiya and Tallahaga Creeks in Neshoba County, the Pearl River Basin meanders over 400 miles and drains over 8,500 square miles through Mississippi and South Louisiana before emptying into the Mississippi Sound (Figures 1 and 2). Major waterbodies include the Pearl, Yockanookany, Strong, and Bogue Chitto Rivers. The basin also includes the state's largest surface source of drinking water, the RBR (RM 301.77). The impoundment inundated approximately 24 miles of the Pearl River, and the normal pool covers approximately 32,000 acres. Also, within the study area, at RM 290.7, is a low weir (Lowhead Dam) built for the city's water supply (in addition to that of RBR).

Several levees and flood control structures exist within the study area. Also, some structures have been elevated above the 100-year flood mark through fill or piling. Two former landfills (Gallatin Street and Jefferson Street) and former Gulf States Creosote plant exist in the project area. One of those, Gallatin Street, extends centrally into the floodplain, further restricting flow.



Figures 1. Map of Pearl River Basin, Mississippi and portion of Louisiana.

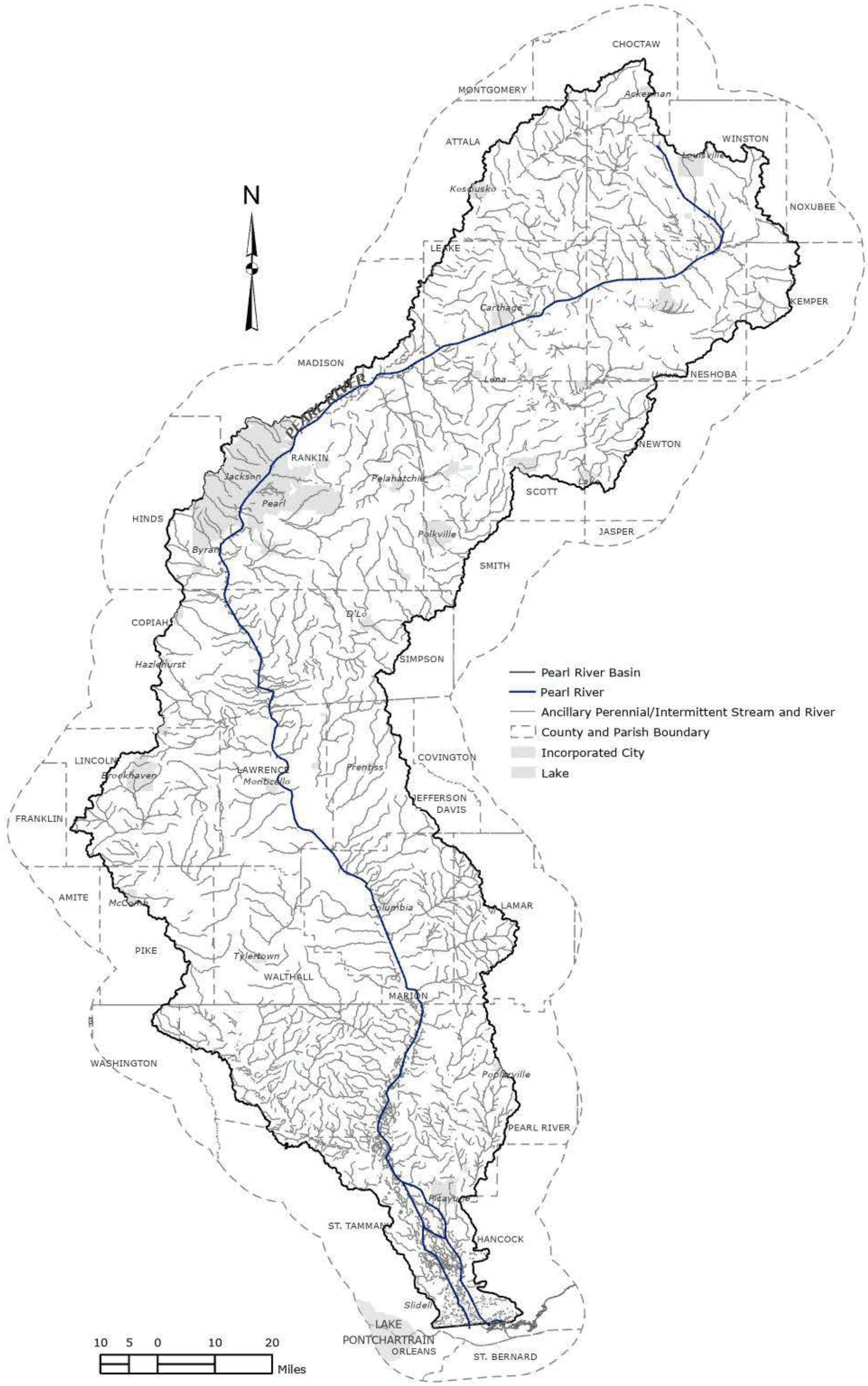


Figure 2. Map of the Pearl River Basin watershed.

The study area focuses on the floodplain from Ross Barnett Dam to just south of Byram (RM 270.0 – RM 301.77) and includes land in Madison, Rankin, and Hinds Counties, MS (Figure 3). The floodplain averages 3 miles wide. Land along this portion includes low swamp areas, pastureland, cropland, forests, residential, and commercial development. This study area is drained by several small tributaries of the Pearl River including Town, Hanging Moss, Eubanks, Lynch, Richland, Hardy, Caney, Purple, and Hog Creeks. Alteration of the 650-foot-wide cleared strip of floodplain along the river contains reduced habitat quality, as do the 13.2 miles of earthen levees. Such flood control features have fragmented and reduced the value of floodplain habitat directly within those areas. However, remaining areas provide higher quality habitat and a travel corridor for wildlife.

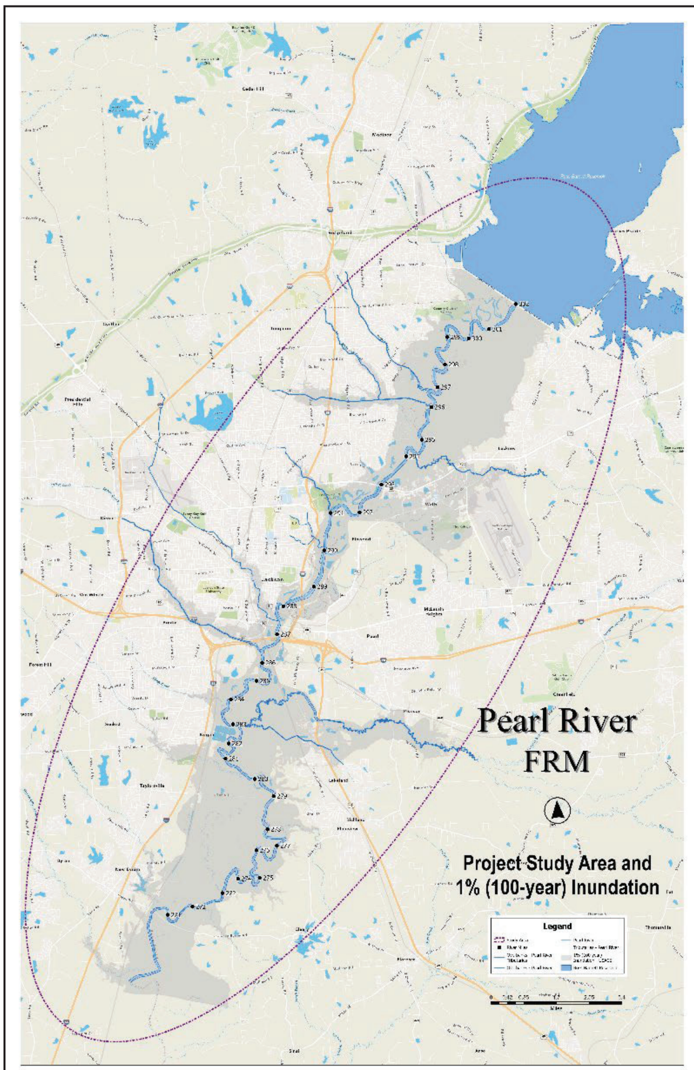


Figure 3. Project study area and 1% (100-year) inundation (MVK).

Water Quality

Water quality in the Pearl River main stem as well as its tributaries varies with some urban tributaries not meeting all water quality standards. According to the Department of Environmental Quality (DEQ), more than half of streams monitored in the Pearl River Basin are rated good or very good, while another 23 percent are rated fair in supporting aquatic resources. Concerns reported from poor water quality include organic enrichment, low dissolved oxygen (DO), and sediment possibly resulting from bank instability and surrounding land uses. Urban influences have reduced water quality within the project area, but may improve downstream with flushing and dilution. During droughts, minimal discharge from the reservoir at times could be below that required for adequate dilution and flushing of the wastewater facilities discharges. Additionally, the DEQ reported ongoing issues with sewage leaking from the city's wastewater pipes and flowing into tributaries and ultimately the Pearl River. As mentioned, there are also several hazardous waste sites located within the study area.

The bed and banks of the river are comprised of silts, sands, sandstone, and clays, including marl, with gravel deposits (Monroe 1954). Overall, the basin has a gentle slope with that of the tributaries being less than 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 less than 2 feet per mile (Monroe 1954; Wilson and Landers 1991).

Lower Pearl River Basin

Due to concerns regarding downstream resources, the Corps plans to assess impacts to the Pearl River downstream of the proposed project to the Mississippi Sound. Downstream of the project area, the Pearl River flows through rural areas, primarily forested, two cities – Columbia and Monticello, and some smaller towns. The Strong River (RM 227) and Silver Creek (RM 186) are the two largest tributaries in Mississippi and the Bogue Chitto River of Louisiana (RM 37) is the largest in the lower Pearl River.

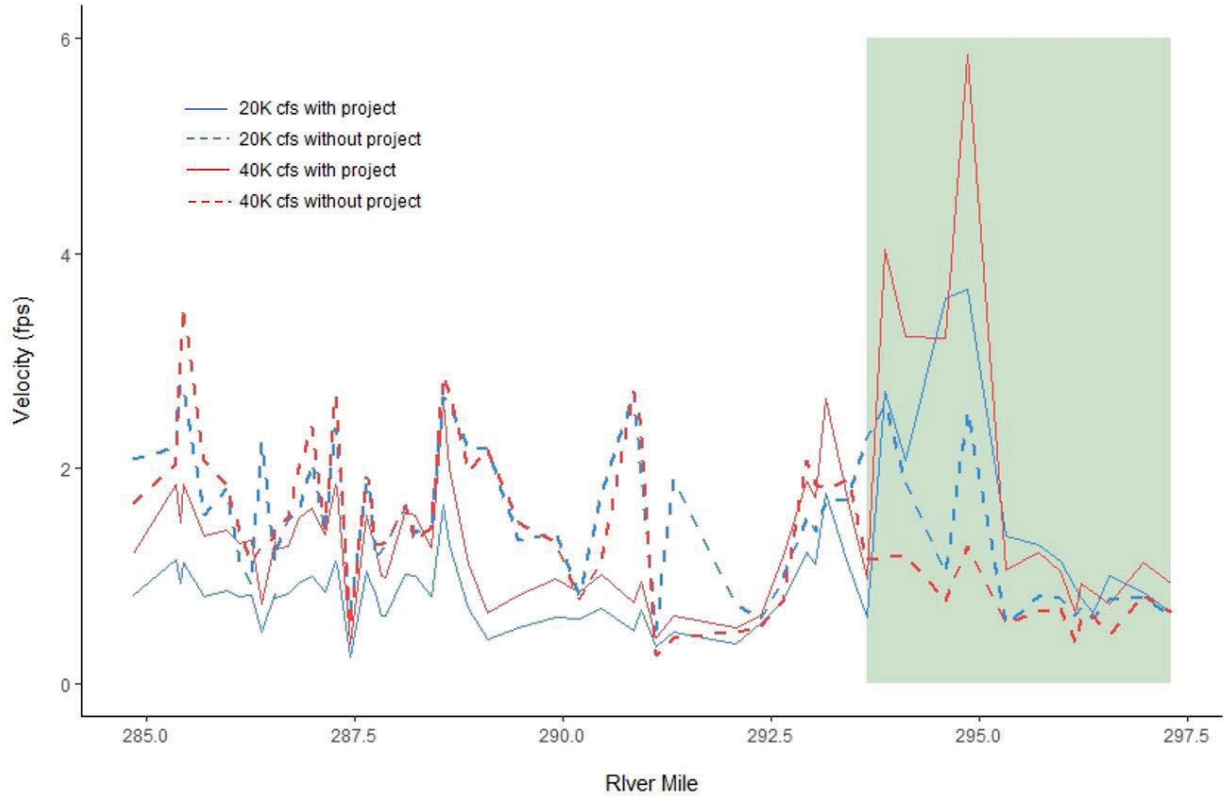
In the lower watershed, two navigation channels have been constructed. One includes three navigation locks in the channel and three sills (*i.e.*, weirs) located on the Bogue Chitto River, Pearl River at Poole's Bluff, and one near the southern navigation lock. The Pearl River becomes braided with numerous bifurcations around Bogalusa, Louisiana which eventually give way to swamps then tidal marshes. Saline marshes occur as a fringe along the Gulf coast. The West Pearl River flows 44 miles emptying into the Rigolets, which is the principal outlet from Lake Pontchatrain into Lake Borgne. The East Pearl flows 45 miles, forming the state line between Mississippi and Louisiana and empties into the Gulf of Mexico via Lake Borgne and Mississippi Sound.

Hydrology

The Ross Barnett Reservoir was constructed in 1961 and was filled by 1965. Operationally, the RBR 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; however, downstream discharge of the Savanna Street Wastewater Treatment Facility is based on a critical low flow of 227 cfs. Thus, 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 RBR is eutrophic with low dissolved oxygen (DO) levels documented in the summer months (Mississippi DEQ 2018, Phallen et al. 1988).

Regarding flow dynamics, Hasse (2006) reported an increase in magnitude of flood and low-flow events post-construction of the RBR and Dam. Parameters used indicated that only 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. As measured at four stream gauge stations, Hasse observed longer low-flow events, an increase in low-flow pulses, and a similar trend in high flow events post-reservoir construction. The increase in hydrograph rise and fall rates post-construction and the increase in hydrograph reversals are typically associated with flow alterations from dams (Hasse 2006).

In Mississippi, greatest rainfall occurs from December through April, producing seasonal influence in the watershed. Previous modeling in the action area under existing conditions indicated that average cross-sectional velocities varied from approximately 0.27 feet per second (fps) to 2.2 fps during high seasonal discharge rates. Typically, the lowest discharge rates occur between June – October (usually not exceeding 5,000 cfs), while the highest rates occur between December – April. Those rates transition between high and low periods in May and November. Discharges greater than 5,000 cfs do not occur between June and November. Rates greater than 20,000 cfs occur infrequently between December and May, usually not exceeding 10,000 cfs. The Service would like to review any new or additional hydrological modeling conducted for the project.



Graph 1. Velocities in the Action Area. Green shade represents area north of the pool. With project velocities represent Alternative C (no instream work proposed for A1, and specific project information is still pending for CTO). Discharges represent high flows.

Biological communities are in a dynamic equilibrium with the hydrological processes associated with a river and its floodplain (Junk et al. 1989). Anthropogenic impacts to this system have altered ecological functions. Ongoing impacts have led to the reduction and/or loss of habitat which contributed to the need for federal protections for species in accordance with the ESA. Protections may be warranted for additional species endemic to the Pearl River due to declines in their populations. Minimizing loss of wildlife and fisheries habitat and proactively conserving natural resources while achieving flood control measures should be considered.

Fish and Wildlife Resources

River systems provide vital ecological functions, natural resources, and ecosystem services for human society. Although it is difficult to place a monetary value on freshwater systems, some reports estimate $8.2 trillion in value provided by these ecosystems in the United States (Bergkamp, et. al, 2000). River and riparian corridors provide commercial and recreational value, flood water storage, bank stabilization, erosion protection, and water filtration. At least 90 percent of sediment eroded from uplands is trapped in alluvial systems (Meade et al. 1990, Saucier 1994).

Many of the habitat types found in the study area are considered imperiled or vulnerable (i.e., bottomland hardwoods, mixed scrub-shrub wetland, emergent wetland/palustrine, riverine, etc.) (Mississippi State Wildlife Action Plan, 2015-2025: https://www.mdwfp.com/media/251788/mississippi_swap_revised_16_september_2016__reduced_.pdf). The Pearl River and its associated oxbows, tributaries, and forested wetlands support biologically diverse species and their habitats. Further, riparian forested areas are an important source of deadwood and other allochthonous materials that provide habitat for many species inhabiting the Pearl River and its tributaries. An inventory report prepared by the Service (1981) provides a detailed listing of species found in the Pearl River Basin (Appendix I).

Aquatic Resources

Considered one of the most biologically diverse rivers in the country, the Pearl supports 140 species of fish (including bass, bluegill, sunfish, crappie, catfish, topminnows, etc.), 14 species of turtles (including the endemic Pearl River map turtle and ringed map turtle), 40 species of mussels, and other aquatic species (MDWFP 2016). One survey identified 44 species of fish within the study area, dominated by minnows, darters, suckers, and sunfishes (Kilgore et al. 2006). Included among those species found, several are considered intolerant or moderately intolerant of habitat changes.

Unmodified riverine ecosystems are important for many aquatic species requiring moving currents and habitat diversity. Aquatic habitat within the study area includes the main stem and tributaries, RBR, several oxbow lakes such as Mayes Lake, channel cutoffs such as Crystal Lake, and several other smaller lakes or ponds. These areas are used by sport fishermen, kayak outfitters, and recreational boaters. Semi-aquatic mammalian associates include beaver, river otter, muskrat, and mink. There is also a great diversity of reptiles and amphibians found within the study area.

The Pearl River hosts areas of firm stable substrate with various sediment types ideal for mussels. They can embed in this habitat 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 contains a diverse compliment of mussels totaling nearly 20 species, including several rare species (Weiland 2000). Within the Pearl River, the proposed threatened Louisiana pigtoe, is found exclusively in the study area and a small portion of the Lower Pearl River (Ellwanger et al. 2023).

Oxbow lakes generally support recreational fisheries due to their valuable spawning and nursery habitat, diverse benthic forage communities, abundant phytoplankton and zooplankton, and structure complexity (Messina and Conner 1998). Oxbows are hydrologically connected to the river when high river stages facilitate fish movement and introduce seasonal pulse of oxygenated river water with nutrient rich sediments. During the summer, any eutrophic tendencies created by upstream closures are intensified, and extreme conditions of warm water temperatures and low dissolved oxygen (DO) concentrations may cause fish mortality.

Sandbars in various stages of development are a typical feature of the Pearl River in the study area. Riverine sandbar habitat, especially unmodified, has high wildlife value. Small fishes concentrate along these features. They also serve as important nesting habitat for turtles and some birds. In fact, within the study area, the threatened ringed map turtle and proposed threatened Pearl River map turtle have been documented using these features for nesting. Although sandbar creation was previously proposed as a conservation measure for the ringed map turtle, we believe these features would need extensive maintenance and monitoring since they could be overtaken by undesirable plant and nontarget turtle species, experience nest predation, and may not be adequately protected from human disturbance.

Since downstream impacts are being analyzed, it’s important to note those resources downstream of the study area. Coastal wetlands of the Pearl River provide nursery and foraging habitat that supports economically important marine fishery species (*i.e.*, spotted seatrout, sand seatrout, southern flounder, Atlantic croaker, spot, Gulf menhaden, striped mullet, white mullet, blue crab, and shrimp). Some of these species serve as prey for other commercially and/or recreationally important fish species. The productivity of the Pearl River estuary contains a significant portion of the total commercial fisheries catch of the Gulf States (Gunter 1967). Menhaden, shrimp, crab, oyster, and mullet are estuarine dependent. This area also ranks in the top 10 for endemic species of reptiles, amphibians, butterflies, and mammals (MDEQ 2008). However, estuaries are sensitive to adverse influences and can be devastated by environment changes. Hurricanes and the Deepwater Horizon oil spill prompted development of a task force strategy that prioritizes restoration and conservation of this important habitat.

The Pearl River estuary freshwater inflow positively influences appropriate salinity characteristics of the Mississippi Sound and Lake Borgne waters. Relatively sharp salinity interfaces occur in some channels, with rises more than 10 ppt occurring within a 5-foot increase in depth. Combinations of precipitation and stream discharge influence fresh water mixing and system evaporation. This estuary is highly productive and rich in nutrients, concentrating and recycling phosphorus and nitrogen. Such nutrient cycling and absorption promote estuarine productivity and dissuade harmful algal blooms.

Terrestrial Resources

The Pearl River floodplain is defined by its hydrology and biogeochemical processes which support important life history strategies for plants and wildlife. Terrestrial habitats in the study area include forested wetlands, agricultural lands, open fields, shrub-scrub habitat, and forested uplands. Forested wetland areas contain bald cypress, tupelo gum, red maple, water oak, willow oak, American elm, swamp hickory, green ash, sycamore, black willow, and other species. Bottomland hardwoods are the primary wildlife habitat type in the floodplain, while cypress-tupelo swamps add to the diversity of this system. The Pearl River Basin serves as a major travel corridor for deer, squirrel, waterfowl, migratory birds, rabbits, fox, raccoon, and others. Additionally, a great diversity of reptiles and amphibians depend on bottomland hardwood, riparian, and aquatic habitats in the study area.

Riparian forests provide important breeding and wintering habitat for bats and a variety of migratory birds. Surveys have identified more than 250 known species of birds in the Pearl River Basin. More than 200 species were identified at LeFleur's Bluff State Park, alone, including prothonotary warbler, Swainson's warbler, Mississippi kite, bald eagle, wood duck, sandpipers, herons, and others. This and several areas within the Pearl River Basin are habitat for stop-over, foraging, and nesting vital for the conservation of bird populations (https://www.stateofthebirds.org/2022/download-pdf-report/) (MDWFP 2016). Many are considered species of greatest conservation need (SGCN, NatureServe and MDWFP 2016), meaning their populations have declined due to emerging threats. In fact, the Golden winged warbler, a species under review for federal protection, ranges within this basin. Quantitative data can be accessed from the Breeding Bird Survey and Christmas Bird Count, (U.S. Geological Survey, https://www.pwrc.usgs.gov/bbs/; Audubon, https://www.audubon.org/conservation/science/christmas-bird-count).

Conservation Lands

Conservation lands within the Pearl River Basin include the Natchez Trace Parkway, Mississippi Choctaw Reservation, Fannye Cook Natural Area, Bienville and Tombigbee National Forests, Lefleur's Bluff State Park, Bienville, Caney Creek (part of U.S. Forest Service), Nanih Waiya, Pearl River, and Old River Wildlife Management Areas (WMA), and Bogue Chitto National Wildlife Refuge. Within the drainage system are the Marion County and Ben's Creek WMAs, Hancock County Coastal Preserve, Mike's Island, White Kitchen Preserve, and Fischer Wildlife Sanctuary. Louisiana designated the West Pearl River and Holmes Bayou as a state Natural and Scenic River System (1976). There is significant acreage along the Pearl River within the focal study area that provides habitat unique for a metropolitan area. These lands not only serve as habitat for wildlife, but also many of them allow non-consumptive recreation and public hunting for game species.

Threatened and Endangered Species

Reports reveal that destabilization and degradation of the Pearl River following construction of the Ross Barnett Reservoir led to a decline in aquatic resources (Tipton et al. 2004). Additionally, research revealed 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 (Piller et al. 2004). Such impacts contributed to extirpation of the Pearl darter, Alabama shad, and freckled darter. The most important measure to assure the continued existence and recovery of listed species is through the maintenance of preferred habitat type and quality.

The Pearl River and associated riparian and wetland habitats in the study area contain suitable habitat for several threatened, endangered, and at-risk species including Gulf sturgeon, Louisiana pigtoe, Monarch butterfly, northern long-eared bat, tri-colored bat, alligator snapping turtle, ringed map turtle, and Pearl River map turtle. It's the responsibility of the Corps to determine whether a proposed action may affect a listed species. In alignment with Section 7(c) of the ESA, the Service recommends that the Corps prepare a biological assessment to determine the effects of the recommended plan on the above-mentioned species. These species are briefly described below.

The northern long-eared bat (*Myotis septentrionalis*), federally listed as an endangered 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. They 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 ringed map (also known as the ringed 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 (Figure 4) for the Atlantic sturgeon in Louisiana, Mississippi, Alabama, and Florida. The proposed project area is 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. These 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).

Figure 4. Designated critical habitat for the Gulf Sturgeon in Mississippi and Louisiana.

As stated, and in alignment with Section 7(c) of the ESA, the Service recommends that the Corps prepare a biological assessment to determine effects of the recommended plan on the above-mentioned species. 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 resulting from any of the above conditions or for changes not covered in this consultation should occur before changes are made and or finalized.

The threatened wood stork (*Mycteria americana*) has been recorded in the action area. It 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 ESA. 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).

Historically found in the Pearl River, but not in the action area, the threatened inflated heelsplitter mussel (*Potamilus inflatus*) occurred 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.

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 Louisiana pigtoe, proposed for federal protection, was recently found within the project area (Ellwanger et al. 2023) and downstream in the West Pearl River. Designation of critical habitat is currently being considered within the project area. The Louisiana pigtoe is a rare freshwater mussel with a thick, inflated, triangular to sub-quadrate shell. The beaks are elevated well above the hinge line but are sometimes eroded. The external shell is without sculpturing and reddish-brown, dark brown, or black in color. The interior shell surface (nacre) is typically white, rarely peach tinted, and iridescent posteriorly. Pseudocardinal teeth (molar-like structures located near the beaks on the interior surface) are heavy to massive, triangular and rough with the anterior tooth in the left valve compressed and parallel to the margin. The lateral teeth, two in the left valve and one with a basal flange in the right, are short and straight or slightly curved. Soft tissues are described as white to off-white. Individuals approaching 5 inches (127 mm) in length have been collected in Texas. The Louisiana Pigtoe is a medium-sized freshwater mussel (shell lengths to greater than 62 mm) with a brown to black, triangular to subquadrate shell without external sculpturing, sometimes with greenish rays.

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. However, it no longer occurs in the action area. Currently this species occurs within the main stem and larger tributaries of the Pearl River beginning at the confluence of the Strong River. 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).

Three petitioned mussel species occur within the Pearl River. The Alabama hickorynut, the Alabama spike, and the delicate spike 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.

Two turtle species proposed for federal protection 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 (USFWS 2021). 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, including those within the study area. The main threats include habitat alteration, exploitation by trappers, pollution, and pesticide accumulation (USFWS 2021). They have been documented at Crystal Lake and in the southern portion of the Ross Barnett Reservoir (Berry 2019). Federal agencies, according to Section 7 of the ESA, must determine whether their actions would jeopardize the continued existence of these species.

Fish and Wildlife Resources Problems and Planning Objectives

The Service acknowledges the need to protect existing urban development from flood damages. However, trends reveal a decline in species diversity and abundance within this basin. Thus, 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 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. Continued development within the floodplain reduces its natural capacity to store flood waters, while necessitating more flood damage solutions. Therefore, there is a need to restrict non-flood compatible development from flood-prone areas.

Urban expansion can cause habitat fragmentation and increased water quality issues that reduce biological diversity. Conversion of bottomland hardwoods and wetlands to other land uses contributes to loss of high value habitat for fish and wildlife. Census data reveal that Jackson's population has declined 26 percent since 1980. Despite this trend, new businesses are being recruited to the area, and subsequent urban growth could result in greater demand for water withdrawals. Coupled with existing water issues, greater withdrawals could impact downstream flows during droughts and can impact fish populations through entrainment and impingement at pump sites.

Hydrological processes are critical to riverine systems. Constructing a large weir or impoundment on a river system can alter conditions permanently, causing significant direct and indirect adverse impacts within and downstream of the project area (Cross et al. 1986, Cross and Moss 1987, Tipton 2004, National Academy of Sciences 1992). Impoundments reduce fish diversity and change the relative abundance of species (Whitley and Campbell 1975, Cross et al. 1986). Other impacts include water quality degradation, altered sediment loads, severe geomorphological changes, and disturbance in freshwater flow to the Mississippi Sound. Hence, riverine obligates may not only decline significantly, but could be extirpated from the system. Consequently, coupled with the loss in function and habitat, mitigation for such impacts could be challenging and costly (National Academy of Sciences 1992, King et al. 1991, Palmer et al. 2005, Michener 2008, Wohl et al. 2005, 2015). In fact, so much is the impact to natural resources and ecosystem services by impounding rivers, that the national trend is to remove these barriers (Loomis 1996, McCully 1997, Lovett 1999). Lake habitat, on the other hand, especially ponds, has increased in the last decade and is deemed common, widespread, and abundant in Mississippi (MDWFP 2016).

To ensure that fish and wildlife resources receive equal consideration with other project purposes, the Service recommends that important riverine habitats, their functions, values, and aquatic communities be conserved, protected, and restored where practicable to provide natural river habitats including flowing waters, heterogeneous microhabitats, and connectivity to backwaters and oxbow lakes. We also recommend important terrestrial habitats be conserved, protected, and restored. The Service recommends the following planning objectives be adopted to guide future planning efforts:

1. Avoid losses of wetlands and riverine habitat. Conserve, protect, and restore riverine habitats and fish communities (including flowing waters with velocities, backwaters, and oxbow lakes representative of the natural river). Any instream structures should provide fish passage.
2. Important terrestrial wildlife habitats (i.e., bottomland hardwoods, cypress swamps, riparian corridors, and sandbars) should be conserved, protected, and restored.

3. Mitigation should be developed on a river basin basis to facilitate conservation of fish and wildlife resources. Measures should include compensation for function and habitat loss of the system.
4. Downstream resources should be conserved, protected, and restored.
5. Detailed measures to offset fish and wildlife resource losses should be determined.
6. A basin wide assessment of the hydrological changes, sedimentation, land use, and water quality should be conducted 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 through the basin.

Section 2036(a) of the Water Resources Development Act of 2000, 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." However, we encourage these tributaries be inspected for opportunities to improve habitat quality when and where practicable (*e.g.*, debris clean-up, erosion control, proper placement and sizing of culverts, etc.). Cropland and pastureland are also classified as Resource Category 4.

Description of National Economic Development Plan and Alternatives

In this phase of national economic development (NED) plan screening, the Corps presented Alternatives A1 – nonstructural solutions, C – channel excavation, widening, levee construction, and large weir construction, and CTO - a combination thereof as alternatives for further consideration. Downstream impacts to the Pearl River Basin will also be assessed.

Alternative A1 has been preliminarily identified as the NED. For this alternative, the Corps inventoried structures in the 10, 25, 50, and 100-year floodplains for elevation (3-13 feet above ground) and floodproofing effectiveness. Floodproofing includes wet or dry floodproofing or retrofitting existing structures. Based on an incremental floodplain analysis, at 10% and 4% incremental annual exceedance probability (AEP) floodplains were both economically justified. Approximately 600 structures, 352 residential and 244 nonresidential, are included in the cumulative 4% AEP floodplain. There’s also an option for nonstructural voluntary property acquisition to be demolished or relocated.

Alternative C is considered the local preferred plan. Construction of this project will require relocations and/or improvements to various public and private utilities and infrastructure, mitigation of potential hazardous, toxic, and radioactive waste (HTRW) and other hazardous waste sites within the floodplain. It will also involve avoidance and minimization measures required under the Endangered Species Act (ESA), and the creation of new habitat mitigation areas to offset losses within the project's construction footprint areas.

Modeling of Alternative C by the Corps considered a variety of upgrades to the non-federal interest's (NFI) routing. These included calibration to the recent 2020 flood event, which had not occurred at the time of the NFI modeling, incorporating more recent flow record data (1980's to 2022), updating all runs to unsteady state routing, including of tributary coincident flow, and the inclusion of lateral structures to represent the levees. Updated calibration has shown that the system response has changed since the 1979 event to be more efficient. The Corps also updated the cost analysis, which included a revised mitigation cost, but does not yet include riverine mitigation costs.

Alternative C consists of the excavation of approximately 25 million cubic yards from the floodplain and channel overbanks - RM 284.0 to RM 293.5 - using heavy equipment. Approximately 2,557 acres would be directly disturbed. The channel widening would range in width from approximately 400 to 2,000 feet. Excavation depths would vary between 5-20 feet to meet the proposed bottom elevation of 248 National Geodetic Vertical Datum (NGVD 29). The total includes 1,692 acres of excavation to widen the channel and 865 acres used for placement of the excavated fill material. Some fill material would be placed in existing wetlands. Excavation limits near existing levees will be determined during final design.

The proposed project includes construction of a 1,500-foot-wide weir structure (weir or dam) at RM 284.0 to create a 1,901-acre modified channel (i.e., lake). The weir will create an approximately 10-mile impoundment with 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). 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.

Upgrades to the existing levee, a slurry wall, and a new federalized levee will be constructed around the Savanna Street Wastewater Treatment Plant. Mayes Lake may require connection and fill, but has not yet been determined. An existing 200-foot-wide weir for drinking water retention located at RM 291 within the project footprint would be removed. A fish by-pass channel around the weir and low flow structure would be constructed on the east bank of the river. Exact design of the fish passage is not yet determined.

The project includes construction of a maintenance berm assumed to extend the entire length of any levee section where water is pooled to limit seepage through the levee. Crown elevation of the berm will be 3 feet above normal pool, a 1V on 40H top slope and a 1V on 3H toe slope. Maintenance and reinforcement of bridge abutments may be required (e.g., placement of riprap, slope paving, slide repairs, etc.). Multiple tributary inflow points will receive hardpoints (i.e., riprap) to prevent backward erosion.

Wooded areas to the east of the proposed new banks and small areas on the west side will be cleared. Excavated fill would be placed in designated disposal areas on the protected side of existing levees, including some wetlands. Fill will be at the same elevation or lower to facilitate future land development. New land mass created behind the levees would range from 200 to over 1,000 feet wide.

Prior descriptions of this alternative noted some sandbar replacement from lost sandbar habitat, but was not mentioned in this project description. Notwithstanding, this feature would require tremendous maintenance and monitoring, and several concerns were expressed regarding their effectiveness in supporting target wildlife species. Thus, it is likely this feature was intentionally removed. Additionally, relocation of ringed map turtles from Crystal Lake, relocation of nests from excavation areas, relocation of mussels, wildlife and water quality monitoring, and adaptive management was also included in previous plans, but not in recent versions. It’s unclear if these measures are still planned components of the project.

Section 3104 Pearl River Basin, Mississippi, of (WRDA) 2007, authorizes that the Secretary may construct the project identified as the NED, locally preferred plan, or some combination thereof. A preliminary CTO alternative was developed by the Corps for flood risk management benefits while reducing costs. Potential components of the CTO include nonstructural solutions as in A1, tributary channel clean-out, flood damage reduction structural measures (*i.e.*, small levees, bridge modifications), and an agreement to address water supply. Many of the features proposed are similar to those of Alternative C, with some minor differences. The primary difference of the CTO is that it does not propose construction of a large weir or impoundment, since further study determined that feature did not provide flood risk management benefits. However, the Corps notes that the NFI or other entity could add a dam or weir at their own costs.

Early iterations of the CTO design included some main stem excavation, including islands within the channel from RM 289.5 to RM 292.0. Excavation was anticipated to extend the same as Alternative C, less the excavation at the Gallatin Street Landfill HTRW site. The total excavation footprint included 374 acres. However, later iterations no longer include mainstem channel excavation or storage measures. No maintenance berms are required. Maintenance and reinforcement of bridge abutments will likely be required, but not yet determined. The Corps plans to coordinate with the Mississippi Department of Transportation on such modifications. Hardpoints will be placed at the base of multiple tributary inflows to prevent backward erosion. Similar levee work is planned for CTO as in Alternative C.

Approximately 600 structures, 352 residential and 244 nonresidential, are included in the cumulative 4% AEP floodplain. These structures have been identified to be preliminarily eligible for the nonstructural alternative. Further, channel cleanout is proposed in the CTO. This includes cleaning out and restoring the channel and floodplain; thereby improving conveyance of water through the project area and lowering the water surface elevation of the tributaries. As a priority, few structures directly adjacent to various channels would require property acquisition with either demolition or relocation.

Principle features include clearing, grubbing, removing, and stockpiling any existing crushed stone surface, debris removal from channel, traverses, adding new crushed stone surfaces, mowing, turfing, erosion control matting, storm water pollution prevention, and environmental protection. Construction will require relocations and/or improvements to various public and private utilities and infrastructure but avoids interaction with potential HTRW and other hazardous waste sites within the floodplain. Preliminary locations (creeks) identified for cleanout include Brashear's, Hanging Moss, White Oak, Purple, Eubanks, Town, Lynch, Cany, and Prairie Branch. Richland Creek is not included due to ongoing work.

Some small levees are planned for construction ranging in width from 25 to 75 feet over 21 linear miles. Fill will be from appropriate excavated material, and any borrow areas will be furnished by the Government. Further consideration of short floodwall and/or berm construction is being analyzed. Areas considered for such work are being prioritized, but not yet confirmed. Bridge modifications and standards are recommended, but pending further analysis. Storage was being considered, but then removed as a consideration on July 28, 2023. There are also options being considered for addressing water supply, but not yet confirmed or determined. The following options were included in the preliminary report: water supply conveyance via pipeline from existing Fewell weir, with improvements to or replacement of existing weir, water supply via a weir similar to the feature described in Alternative C to include limited channel clean-out, dredging, and drainage mitigation.

Much of the CTO is still under development and analysis. Thus, determining impacts to fish and wildlife resources will be challenging and lacking. It's also unclear if Alternative C and CTO plan are going to provide a complete watershed analysis, velocity report, and sediment analysis. This information is needed to determine impacts. The current plan description states that implementation would proceed with a more detailed analysis of the potential additional structural measures including environmental assessments (i.e., downstream impacts). Incorporating flood risk reduction features, especially nonstructural solutions, while avoiding construction of a large weir or impoundment can reduce impacts to natural resources and potential mitigation requirements. However, project details and analysis are pending.

Description of Impacts

Of the alternatives considered, Alternative A1 is expected to have the least impacts to fish and wildlife resources because no instream work would be conducted, and no aquatic or forested habitat would be impacted. The proposed work would rehabilitate existing infrastructure within the existing footprint (*e.g.*, elevating structures, floodproofing structures, and modifications to existing elements). The Corps identified A1 as the preliminary NED.

Section 3104 Pearl River Basin, Mississippi, of (WRDA) 2007, authorizes that the Secretary may construct the project identified as the national economic development plan, or the locally preferred plan, or some combination thereof. This plan involves features of the nonstructural plan, A1, and flood damage reduction structural measures (i.e., channel cleanout, excavation, small levee construction, bridge modifications, and addressing water supply issues). More information from this plan is pending; hence, determination of impacts to fish and wildlife will be conducted fully when this information is received. A final project description and watershed analysis could aid in this assessment. Notwithstanding, examining existing non-structural alternatives along with a flood protection solution that doesn't permanently alter water velocities and flow regimes within the action area (i.e., without construction of a large weir or impoundment) could greatly reduce riverine impacts. The Service recommends further coordination regarding the CTO to realize impacts and make conservation recommendations.

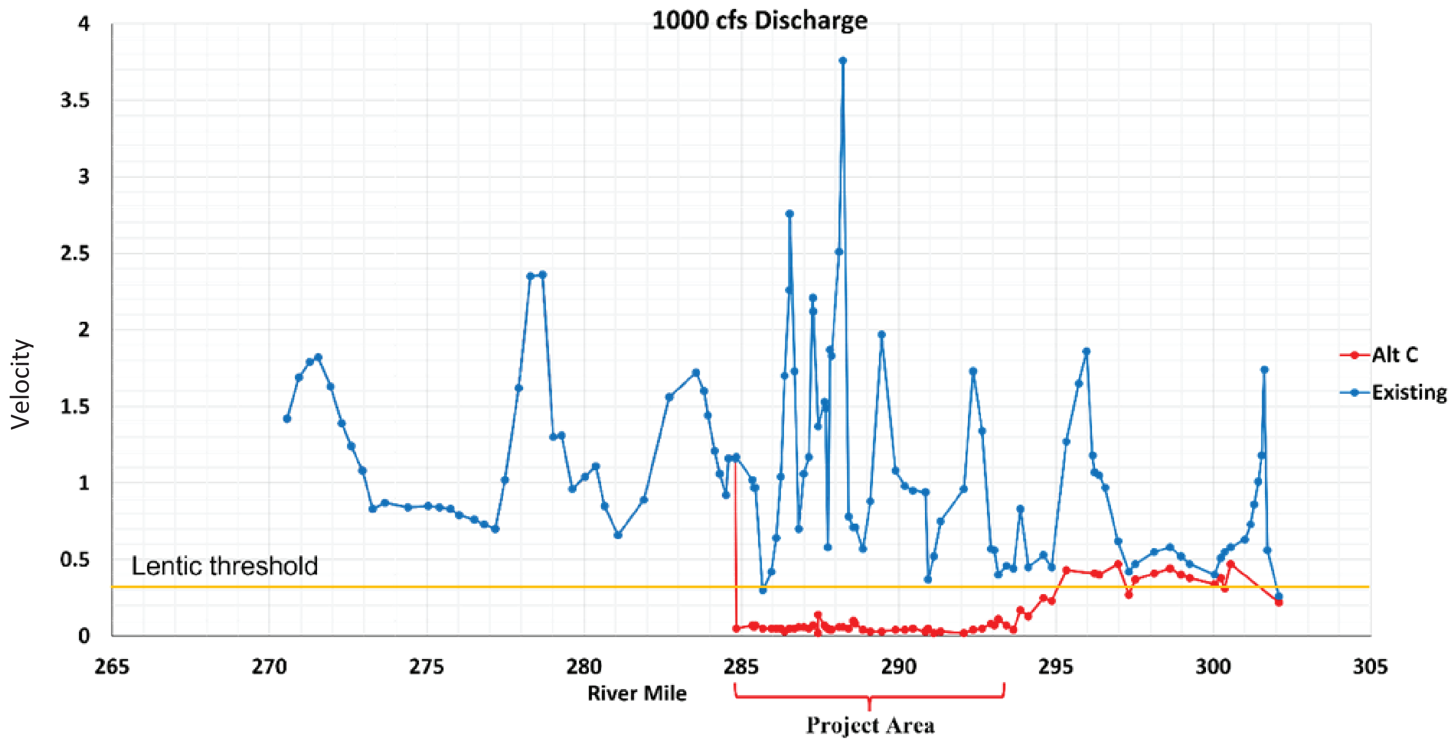
Although we report on all alternatives considered, the Service notes that the Channel Improvements Plan (Alternative C) was previously identified as the most ecologically damaging alternative. Based on current project information, approximately 2,557 acres of terrestrial habitat would be converted to aquatic habitat. Approximately 1,861 acres of wetlands and ''other waters of the U.S.'' and approximately 487 acres of existing surface water bodies, including the Pearl River channel and its tributaries, would be impacted. Additionally, converting the portion of the Pearl River within the project area from a riverine system to a lake system will have impacts on threatened and endangered species, and will impact resources downstream.

The Channel Improvements Plan (Alternative C) is still considered the most damaging alternative for both terrestrial and aquatic resources. Primary impacts from this project include:

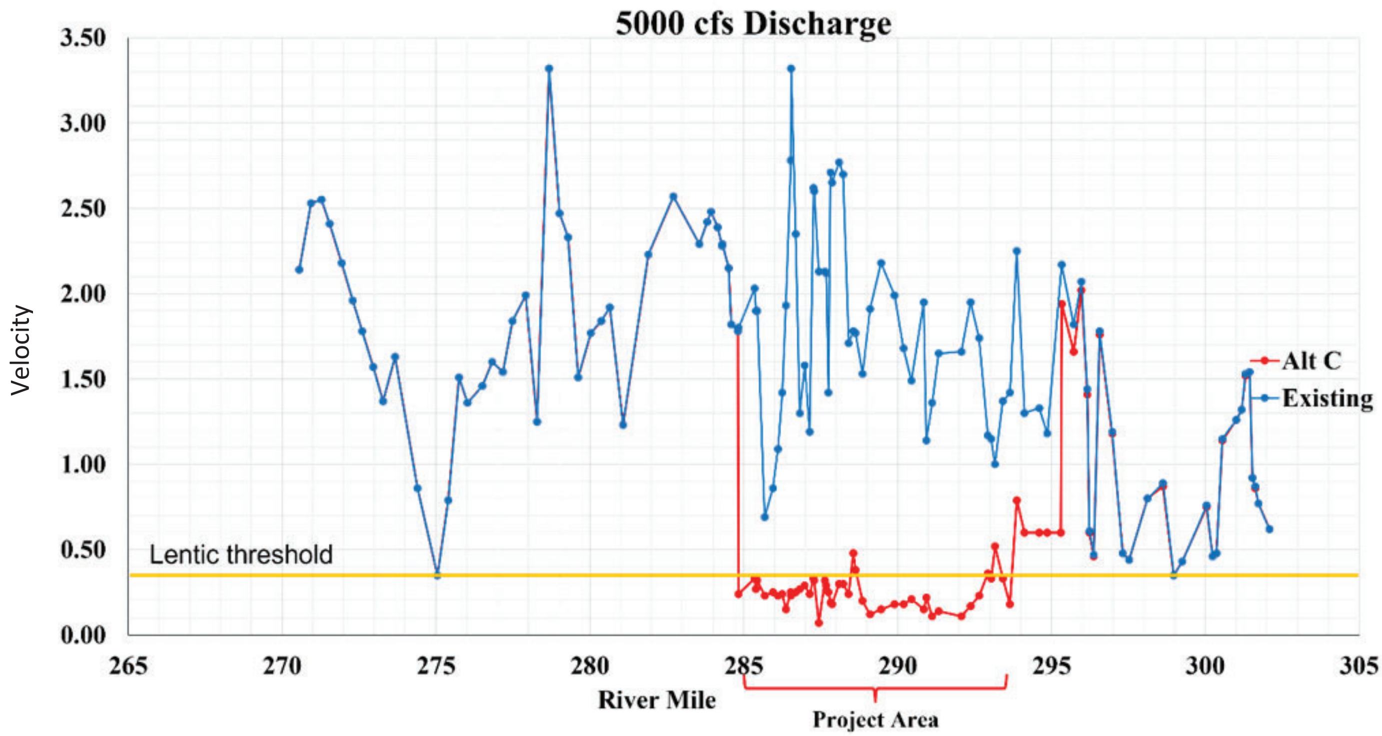
1. Loss of habitat diversity and concomitant aquatic species diversity resulting from conversion of the Pearl River into a wide excavated channel (or relatively slack-water pool);
2. Direct and indirect loss of riparian woodlands and other terrestrial habitats important to fish and wildlife resources;
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 readjustment 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.

This plan proposes dredging, channel widening, placing fill material, and construction of a large weir near RM 284.3 that could permanently alter the water regime over 9 miles of the Pearl River, transforming the river into a more lentic (lake-like) water body, while altering geomorphology downstream. While some species can thrive in lentic habitats (e.g., gizzard shad, bluegill, and largemouth bass), others, such as riverine obligates (e.g., Pearl River map turtle, Louisiana pigtoe, and darters), cannot exist in such habitats. As demonstrated by the models (Graphs 2-5), velocities in the proposed action area could be significantly reduced approximately 73 percent of the time, interrupting important life history strategies (i.e., prey sources, breeding substrate, etc.). Further, barriers restrict fish movements and alter aquatic species communities.

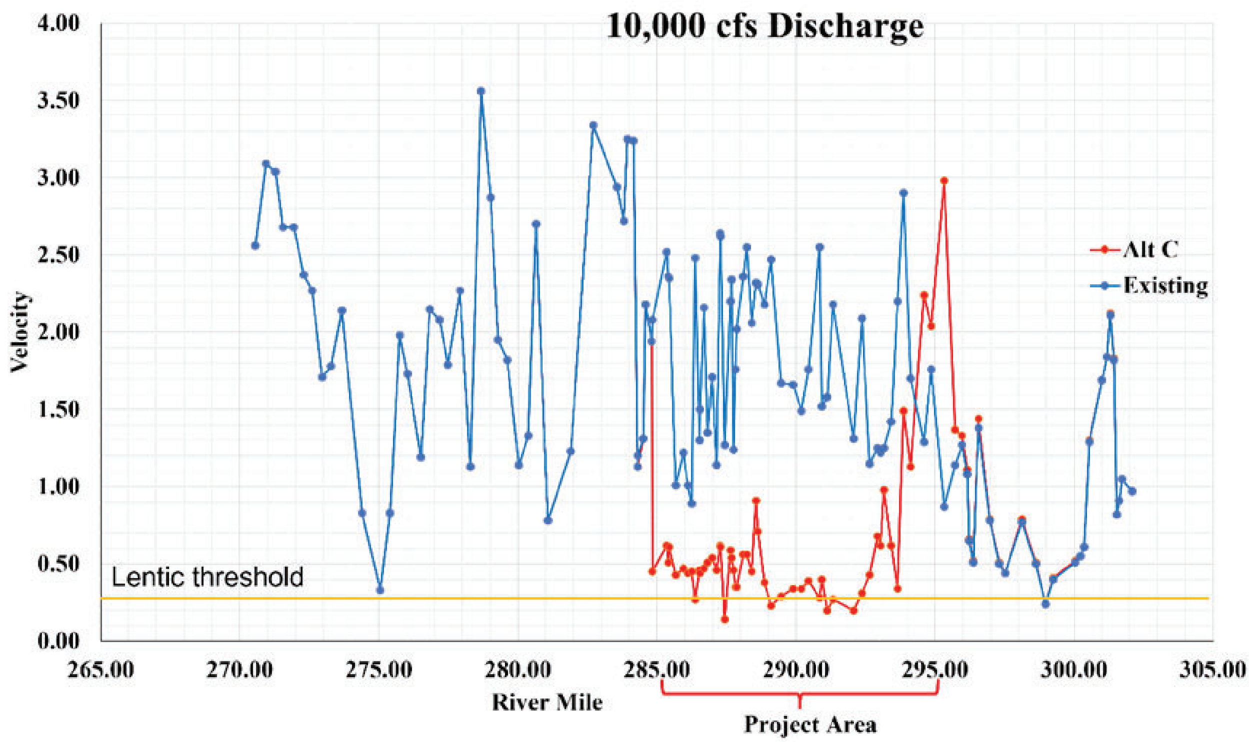
Based on available data, with Alternative C, the range of velocities reported fall below the lentic threshold of 0.10 m/s (0.33 ft/s) (Pellett et al. 1983) throughout most of the year, particularly during the active or breeding season for many riverine obligates. The graphs below depict pre- and post-project (Alternative C) velocities within the study area (which includes the pooled area) for 1,000 cfs, 5,000 cfs, 10,000 cfs, and 20,000 cfs.



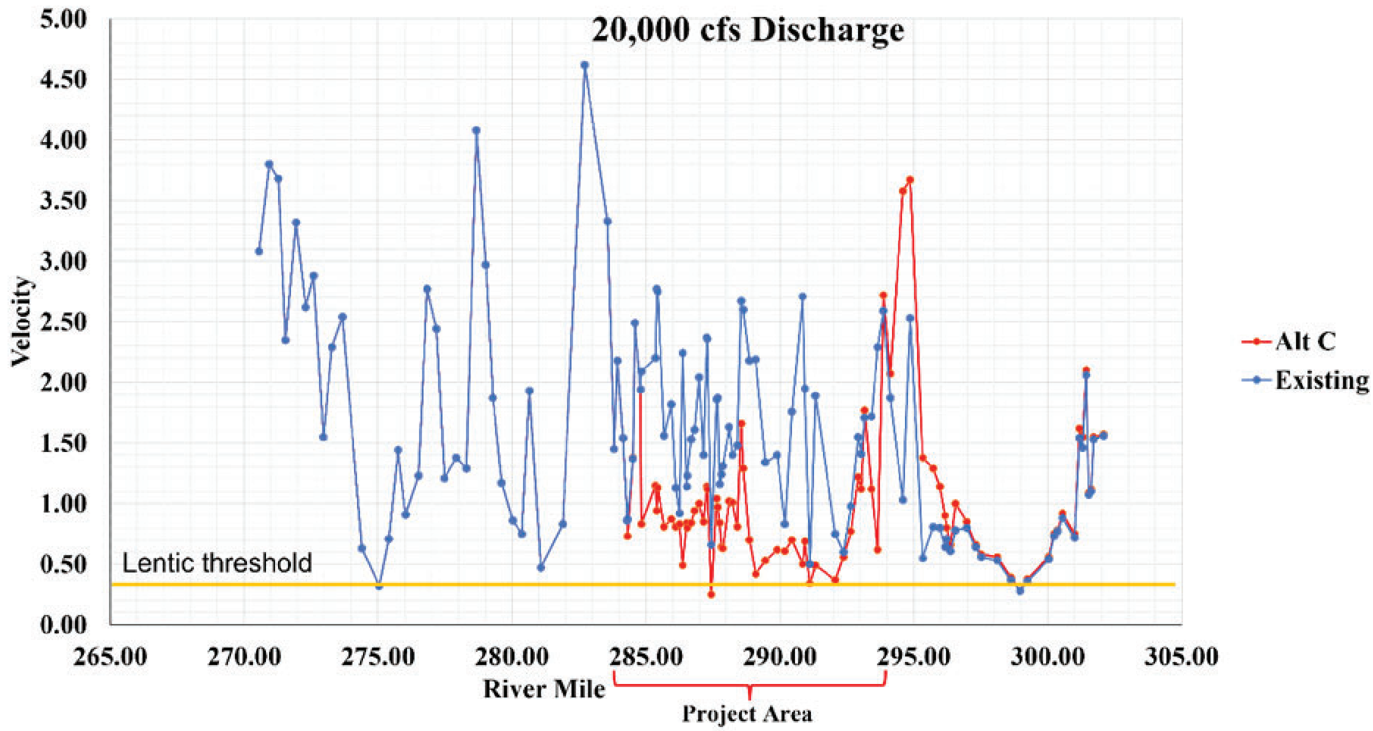
Graph 2. Existing velocities at 1,000 cfs discharge rate compared to project induced velocities. Lentic threshold of velocity is 0.10 m/s (0.33 ft/s) (Pellet et al. 1983). Monthly discharge averages (1966-2013) presented from RM 270 – RM 302.



Graph 3. Existing velocities at 5,000 cfs discharge rate compared to project induced velocities. Lentic threshold of velocity is 0.10 m/s (0.33 ft/s) (Pellet et al. 1983). Monthly discharge averages (1966-2013) presented from RM 270 – RM 302.



Graph 4. Existing velocities at 10,000 cfs discharge rate compared to project induced velocities. Lentic threshold of velocity is 0.10 m/s (0.33 ft/s) (Pellet et al. 1983). Monthly discharge averages (1966-2013) presented from RM 270 – RM 302. Note: Discharges at or above 10,000 cfs are only reported to occur in the pooled area approximately 13 percent of the time, during anticipated high flow season (December-April).



Graph 5. Existing velocities at 20,000 cfs discharge rate compared to project induced velocities. Lentic threshold of velocity is 0.10 m/s (0.33 ft/s) (Pellet et al. 1983). Monthly discharge averages (1966-2013) presented from RM 270 – RM 302. Note: Discharges at or above 20,000 cfs occur infrequently.

Average annual discharge in the project area is 4,700 cfs. Based on current data, average discharges greater than 20,000 cfs do not occur at any time throughout the year. Only 9 percent of the daily Jackson gage records (1966-2013) show discharges between 10,000 and 20,000 cfs. Average discharges greater than 20,000 cfs occur infrequently. Even throughout predicted high flow season (December – April), average discharges reported are less than 10,000 cfs in the area. Consequently, three of those months are considered inactive season for some riverine species (*i.e.*, map turtles). Noteworthy, with project modifications, once discharges decrease below 10,000 cfs, the modified channel's velocities would significantly decrease and lake like velocities would occur (below 0.33 fps; Graphs 2-4). Low flow conditions (Graph 2-3) are expected to occur throughout most of the year with approximately 73 percent of daily gage records below 5,000 cfs (268 days per year).

Lotic-like velocities ranging from 0.75 – 3.3 fps exist in the project area under the average discharge conditions of 4,700 cfs. However, post project construction, velocities fall below the lentic threshold at discharges below 20,000 cfs (Graphs 2-5). That project-induced lentic condition persists throughout the channelized reach (RM 284 – RM 294) especially at/and below average flow conditions (*i.e.*, ≤ 5,000 cfs; Graphs 2-4) mentioned above. Further, at discharge rates ≤ 1,000 cfs, average velocities will be reduced from 1.15 fps (range 0.3 – 3.7 fps) to 0.06 fps (range 0.02 – 0.17 fps), below the lentic threshold (Graph 2). This trend remains fairly constant throughout the modified channel portion with variations caused primarily by differences in the proposed cross-section of the channel.

At infrequent high flows (*i.e.*, 40,000 cfs or greater), a significant reduction in velocity is not anticipated within the channelized reach. Neither are velocities at discharges of 5,000 – 20,000 cfs expected to be significantly different (pre- and post-project scenarios) in the reach beyond the channelized section; north of RM 297 (Graphs 3-4). However, a project-induced increase in velocity in a portion just upstream of the upper limit of the pool (approximately RM 296 – RM 297) (Graphs 1, 4-5) is anticipated at discharges above 10,000 cfs.

Between RM 293 (upper end of the improved channel) and RM 295 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 fps to 5.85 fps for discharges greater than 40,000 cfs. This decrease in water surface and increase in velocities could result in scouring and destabilization of the banks (i.e., head cutting).

Alterations in riverine and riparian forest conditions are expected to have long-term negative impacts to several at-risk aquatic species potentially found within the action area. Even the Alligator snapping turtle, which persists in slow-moving waters, prefers habitat structure (e.g., tree roots, snags, etc.). Therefore, 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 may partially offset loss of such structure; however, they would quickly decay, needing constant replacement. Retrieval of trees along the stream as replacement structure is not recommended since it would further reduce habitat along those areas.

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 other at-risk species. Populations of the Alabama hickorynut, delicate spike, and Louisiana pigtoe are present in the project area and we anticipate extirpation 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. We also anticipate a reduction or extirpation of the Pearl River map turtle in the action area. Other turtle species (red-eared slider) more adapted to slow-flow conditions would likely flourish in the impoundment (Selman 2018) and displace the Pearl River map turtle.

Changes in water flows from impoundments cause detrimental effects (Poff et al. 1997, Postel and Richter 2003). They could alter water temperature, chemistry, transport, and distribution of sediments, and could also cause changes in geomorphology. Other threats to downstream flows include unregulated water withdrawals and extractions, sewage disposal, and land-use changes. Such threats and alterations in natural flows can lead to adverse impacts to wildlife and habitat. For example, the Pearl River sustained long- and short-term impacts from construction of the Ross Barnett Reservoir. Construction of the dam created extensive downstream erosion, sedimentation, and other hydro-geomorphological changes that reportedly destabilized the system (Tipton 2004, Piller et al. 2004). These changes likely contributed to the loss or reduction of several species within the Pearl River drainage. Sensitive mussel species were eliminated from the main channel (*i.e*., Alabama hickorynut, inflated heelsplitter) and the Strong River (*i.e*., Alabama spike, black sandshell) (Ellwanger et al. 2023). Some species of fish (i.e., crystal darter, frecklebelly madtom) experienced sharp population declines, not returning to pre-construction status until decades later. Still other sensitive fish species were extirpated (i.e., Pearl darter, Alabama shad, and freckled darter).

In addition to a loss of species and habitat diversity due to an altered flow regime, there could be a direct and indirect loss of terrestrial habitats and their functions important for wildlife. There may also be a loss of sandbar habitat due to increased water levels or to undesirable vegetation encroachment resulting from stabilized water levels. Santucci et al. (2005) reported that 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. Additionally, the potential for up- and downstream channel re-adjustments may cause other hydrogeomorphic changes to the Pearl River and its tributaries within and outside of the project area. Other concerns include impacts to conservation lands within (*i.e*., Fannye Cook Preserve, Lefleur's Bluff, Maye's Lake) and downstream of the project area, the reduction in sediments to coastal marshes, and loss of flows.

We anticipate impacts from channel improvement actions such as dredging and widening of the channel. Such actions could cause direct and indirect harm to natural resources. Dredging can reduce prey species, remove shelter and spawning habitat, and cause mortality to turtles, mussels and fish. Channel widening could destabilize the banks, change flow regime, alter instream and terrestrial habitat, increase water temperatures, and cause direct mortality of some species. Additionally, sediment plumes from these actions can smother species both within the project footprint and downstream. However, depending on the morphology, structure, and depth of the river after dredging, some species may recolonize if no barriers exist. Due to construction of large weir, we anticipate permanent adverse impacts to riverine obligates.

Construction, future development, and maintenance activities could cause longterm impacts to water quality resulting from pollutants, storm run-off, and changes in sediment transport. During construction, the project could result in temporary increases in sediment and turbidity in the main stem and tributaries within the study area and downstream. Increased turbidity can interfere with light penetration and reduce photosynthesis while increased sediments can adversely impact benthic populations of aquatic species. If construction activities occur during the spawning season, increased sediment would smother invertebrates, fish eggs, and larvae. Increased sediment could also smother mussel beds. Conversely, sediment trapping behind the weir can reduce sediment flow downstream, causing longterm adverse impacts to aquatic species habitat and life history strategies. Reduced sediment transport could also result in increased downstream erosion (Csiki and Rhoads 2010).

Further, we have concerns regarding bank stabilization and leaching of waste from the proposed relocations and removal of existing solid waste units, removal and capping of existing potential HTRW sites, and adequate remediation of those areas. Fisheries habitat can be adversely impacted by water quality degradation. Due to municipal and industrial outfalls, DO concentrations often fall below 5.0 milligrams per liter (mg/l), especially below Jackson, Monticello, Columbia, and Bogalusa. These DO levels have sagged as far as 100 miles downstream due to failures in Jackson's waste treatment plant (Seyfarth 1980), resulting in negative impacts to aquatic resources. Increased turbidity and sedimentation can further impact these resources. Periodic drawdowns in reservoirs often leave shallow water that limits normal fish reproduction. We anticipate short and long-term impacts to water quality from construction activities, vegetation clearing, changes in hydrogeomorphology, and future development. As mentioned in the modeling report, the project should analyze water quality and sedimentation throughout the watershed related to this project.

Previously, the project reported riverine impacts up to 1.6 miles downstream. However, many variables can contribute to downstream impacts, including changes in the river's width and depth, geology, channel confinement, slope, height of dam compared to bank height, etc. Contradicting the 1.6-mile downstream impact zone, recent models developed by the Corps show impacts extending roughly 66 miles downstream to Copiah Creek just South of Georgetown, Mississippi. Not only is this river reach important to aquatic organisms, but the area also contains one of the largest tributaries to the Pearl River, the Strong River, where listed species recovery work is occurring. Several studies examined impacts downstream of impoundments and found declines in species associated with gravel substrates (*e.g.,* frecklebelly madtom) and those intolerant of geomorphological instability (*i.e*., darters). Such declines were attributed to water resource projects, land use practices, and changes in sedimentation (Tipton et al. 2004, Piller et al. 2004). Since we expect similar impacts from this project, we agree with the Corps that further watershed and sedimentation analysis would be helpful in confirming downstream impacts. Furthermore, the proposed fish passage around the weir may allow continued fish migration for some species; however, the design and operation should be defined, and velocities, sediment, and water quality through the passage identified before confirming that this feature will be beneficial for many species of concern.

The project would also result in direct loss of forested wetlands and associated wildlife habitat. Since out-of-bank overflows maintain forested and/or scrub-shrub wetlands, channelization proposed for this project could further impact these forested wetlands by preventing or reducing those overflows. Additionally, disturbed areas along the banks would be exposed and vulnerable to erosion until vegetation becomes established. Clearing and constructing levees would further fragment remaining forests. 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.

The Service classifies wetlands within the project area as Resource Category 2 habitat, as defined in the FWS Mitigation Policy (FR, Vol. 46, No. 15, January 23, 1981). This resource 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 this habitat is "no net loss of in-kind habitat value". Terrestrial habitat within the Pearl River Basin supports more than 400 species (Service, 1981). Some wetlands within the action area could be directly impacted, such as areas in and near Lefleur's Bluff (*i.e.*, Mayes Lake), around Crystal Lake, and other areas as fill material is placed. Environmental guidelines (40 C.F.R. § 230.91(c)) prescribe that dredged or fill material should not be discharged into the aquatic ecosystem unless it can be demonstrated that such a discharge will not have an unacceptable adverse impact either individually or in combination with known and/or probable impacts of other activities affecting the ecosystems of concern. From a national perspective, the degradation or destruction of special aquatic sites, such as filling operations in wetlands, is considered to be among the most severe environmental impacts covered by those guidelines. The guiding principle should be that degradation or destruction of special sites may represent an irreversible loss of valuable aquatic resources (Federal Water Pollution Control Act, 33 U.S.C. 1344 (b)(1); 40 CFR 230.1).

Increasing development along the Pearl River could contribute to cumulative impacts from this project. Should further development occur, it would remove high priority forested wetlands, reduce habitat available for wildlife, reduce floodplain water storage capacity and filtration, and degrade water quality. Removing vegetation along the banks could increase instability, run-off, and temperatures, damaging aquatic species habitat. Further, removing forested vegetation and increasing impervious services could cause eutrophication of water bodies. A visual representation of concentrated sediments resulting from construction along Pelahatchie Bay can serve as an example of impacts to water quality from development activities (Figure 5). The Mississippi Department of Health reported that rains and floodwaters created a chemical imbalance on one side of the water treatment plant from RBR intake water, leading to a loss of pressure (Clarion Ledger, August 2022).

Figure 5. Aerial visual (2020) of sedimentation in Pelahatchie Bay from construction activities.

The Corps model for the 100-year without project routing scenario indicated no significant change in flood risk reduction, particularly along tributaries within the project area. Significant flood damages occurring in the study area are associated with backwater flooding of the Pearl River. Based on this preliminary analysis, the Service is concerned that the extensive adverse impacts of the project may outweigh the benefits, considering the flood risk objectives may not be fully realized.

Anthropogenic impacts to river basins are complex (Bergkamp et al. 2000, National Academy of Sciences 1992, Pringle 2001, and Ward and Stanford 1989). These basins contain aquatic habitats within the river channel from the headwaters to the sea, elements of the river catchment and landscape, inputs to the river, riparian areas, groundwater throughout the basin, floodplains, wetlands, estuaries, and its associated system resources. Impoundments constructed on rivers interrupt the complex ecosystem continuum that exists within its network. Some of the functions lost when impounding a river include flood control and storm protection, wildlife and fish habitat, forest resources, water quality and quantity. Furthermore, reduction in downstream flooding and water quality affect biodiversity, floodplains, deltas, and estuaries (Rosenberg et al. 1997, McCully 1996, Dynesius and Nilsson 1994, Gillilan and Brown, 1997, Olsen et al. 2006). Multiple impoundments can increase sedimentation entrapment, further reduce or inhibit fish passage and reduce genetic flow of organisms.

Habitat Evaluation Procedures Analysis

Habitat Evaluation Procedures (HEP) are a habitat-based evaluation system that produces 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 (Service 1980a, 1980b). Formerly, the Service recommended that future planning and mitigation efforts should use the Corps' Engineering Research and Development Center (ERDC) impact and mitigation analysis, since it more appropriately captured riverine species. 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. However, due to time constraints, the NFI's HEP was used to quantify the potential impacts to fish and wildlife species resulting from construction. Since there were some discrepancies in the NFI's reported results, we formed an interagency mitigation team (IMT) to review existing HEP. The team collaborated on habitat types, used existing acreages, and revised average annual habitat units (AAHUs) accordingly. Noteworthy, a mitigation plan is being developed by the Corp in collaboration with the IMT. It has not been determined if this plan would fully mitigate AAHUs lost by riverine species.

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 to display benefits and costs of a project. Federal projects are evaluated over a period 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, resulting in 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 AAHUs 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 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 NFI 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.

HEP allows the determination of mitigation using one of three compensation goals. The in-kind (no trade-off) goal 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) goal 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.

Habitat Type	Quantity (acres)	Quantity (AAHU's)
Emergent wetland/palustrine	462.41	-958.56
Lacustrine	200.9	1266.56
Swamp	149.8	-310.48
BLH wet/Scrub-Shrub Wetland	1017.84	-2109.94
Riverine	287.16	-1237.72
Forested uplands	904.42	-2733

Table 1. Unavoidable fish and wildlife habitat impacts – habitat type in proposed action area and model results for each impacted habitat types quantified using AAHUs for Alternative C.

The IMT agreed that riverine impacts would need to be mitigated in-kind. The pool-like environment behind the weir would not compensate for lost riverine habitat and function. Although challenging, the IMT is collaborating on compensatory mitigation and a plan is being developed with the goal of fully compensating for the unavoidable impacts to significant fish and wildlife habitat resources and riverine function loss that would occur. Preliminary analysis shows total mitigation costs (based on bank credit purchase) for forest types and palustrine habitat could exceed $1 billion, which excludes riverine mitigation costs. We expect riverine mitigation to be costly since both function and habitat loss need to be compensated. Therefore, costs would greatly exceed $1 billion. Pending final plan details for the CTO, we assumed that riverine habitat may not be impacted to the extent in the CTO as it would be by Alternative C, and that it would not be impacted by Alternative A1. Thus, mitigation may not be necessary for Alternative A1 and, pending final details, may not be as great for the CTO alternative as it would be for Alternative C.

From the HEP, it was determined that impacts from Alternative C and CTO would be similar excluding riverine impacts. Out of the evaluation species used, it was determined that the swamp rabbit sustained the highest loss (Appendix 2), while largemouth bass may be benefited by Alternative C, since they can tolerate more lentic conditions. It should be noted that the Corps' previous analysis indicated that riverine obligate species (*e.g*., darters, suckers), which represents 20 percent of the fish assemblage, would no longer persist after construction and facultative riverine species (*e.g*., catfish, shiners, minnows) numbers could be adversely impacted (Kilgore et al. 2006).

The IMT is considering mitigation lands, strategies, and measures to compensate for impacts to resources. The sites are being systematically and qualitatively identified, but have not yet been chosen. Commercial mitigation bank credit purchase, habitat restoration, habitat enhancement, high quality habitat preservation, hydrological restoration/enhancement, and habitat connectivity are all being considered with various measures and success criteria being developed for each. Noteworthy, mitigation bank credits are not currently available for all habitat types and quantities. Once lands are identified, site specific projects will be assessed and may be combined with bank credit and Corps constructed mitigation. The Service proposes to work closely with the Corps in developing plans, site selection, monitoring, and related items.

Conservation Measures and Recommendations

In response to concerns presented in previous assessments, the Corps is assessing 3 different alternatives including nonstructural solutions (Alternative A1), channel improvements with construction of a large weir (Alternative C), and a combination thereof (CTO). The former tentatively selected plan (Alternative C) was identified as the most environmentally damaging alternative. Nonstructural solutions are expected to produce the smallest environmental impact compared to other alternatives, because no instream work would be conducted, and no aquatic or forested habitat would be impacted. While the CTO is still being developed, if no weir or impoundment is constructed, then we anticipate that it will still produce less ecologically damaging and permanent impacts than that of a river impoundment. Flood reduction measures, such as levee setbacks, removal of flow impediments and pinch-points, implementing additional conveyance improvements at flow impediments, and nonstructural measures could reduce flood stage elevations. Most 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.

Impacts to fish and wildlife resources should be avoided and minimized to the extent practicable, particularly by avoiding major modifications to the Pearl River and its floodplain. Since there are unavoidable losses of wildlife resources associated with Alternative C and likely the CTO, habitat compensation is appropriate. The Service requests final plan details, potential impacts, and proposed mitigation for the CTO. However, we emphasize, that if an impoundment is not constructed, permanently altering the river system, then we anticipate impacts and mitigation for that alternative may not be as great as that of Alternative C. Alternative C would permanently replace approximately 9.5 miles of riverine habitat with a lentic environment. Based on velocity data, low flow conditions are estimated to persist most of the year, particularly during critical life stages of aquatic species (*i.e.*, breeding, feeding, etc.). Such conditions would favor more lentic tolerant species, eventually displacing riverine obligates. Many of these riverine obligate species, including some that are considered at-risk species, would decline or be extirpated from the action area. Impacts to federally listed species should be addressed via ESA section 7 consultation.

Many experts indicate that riverine mitigation is challenging, since loss of both habitat and function are difficult to compensate (National Academy of Sciences 1992, King et al. 1991, MacCrimmon 1968, Berger 1991). Mitigation efforts that restore in-stream functions elsewhere within the range of the at-risk species could offset expected habitat loss to those resources. Mitigation efforts on the main stem of the Pearl River and its tributaries (e.g., Strong River) should be a priority. Measures to promote fish passage, such as removing obsolete barriers (i.e., Poole's Bluff weir, West Pearl lock and dam), constructing fish passage features on existing barriers, and incorporating monitoring and adaptive management could benefit the southeastern blue sucker, American shad, American eel, various darters, mussels, and others.

Riparian protection via land acquisition or conservation easements could provide benefits to at-risk species through removal of threats associated with sedimentation and riparian forest loss. Maintaining or implementing vegetated streamside management zones in agricultural areas could also stabilize the bank, protect water quality, benefit aquatic habitat, and provide habitat and travel corridors for wildlife. Removing threats associated with channel clearing/desnagging could also provide benefits to the Pearl River map turtle and other riverine turtles. Many of these conservation efforts could also benefit freshwater mussels, one of the most imperiled taxonomic groups in the country.

The vulnerable riverine sandbar habitat, especially the less modified sites located outside of the channelized areas, 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 and Pearl River map turtles and should explore the inclusion of measures to help protect and restore habitat for those Pearl River endemic species.

A watershed and sedimentation analysis could aid in determining impacts and developing mitigation measures. Where the Pearl River and tributary stream water levels will be increased or decreased by project implementation, the potential extent of resulting channel re-adjustment or other hydrogeomorphic changes (e.g., bank erosion, channel incision) should be analyzed and appropriate mitigation measures implemented, 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. The potential for reduced flows during droughts and the resulting impact to downstream aquatic resources is a concern. Reduced flows could result in poor water quality conditions from downstream discharges further impacting aquatic resources.

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 increased loss or decline of riverine dependent species, including some at-risk species, within the watershed and the loss of species diversity. Therefore, the Corps with other water resource development agencies should include an additional planning objective to address this basin-wide problem.

In addition to those mentioned above, the following recommendations are provided particularly for Alternative C, but should also be considered when developing the CTO. To make appropriate recommendations for the CTO alternative, the Service requests design details and potential impacts once finalized.

1. Further description and analysis of dam construction, operation, and maintenance should be provided.
2. Adequate turbidity, silt, and spoil containment barriers should be used to protect aquatic and wetland resources.
3. Incorporate sediment and erosion control measures during construction and re-vegetate all disturbed areas immediately following construction. Incorporate measures to identify potential erosion issues, and control erosion and potential headcutting downstream.
4. Continue to include the Service in planning and project collaboration to evaluate and oversee environmental efforts.

5. Mitigation should be implemented concurrent with construction.
6. Mitigation for unavoidable losses of fish and wildlife habitat, as reflected by loss of Average Annual Habitat Units (AAHUs), as well as loss of function, should be implemented within the Pearl River Basin. We recommend maintaining the interagency mitigation team for planning, coordination, future sampling and HEP analysis. At minimum 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. incorporate a public land measure for any impacts to public lands;
    e. identification of the entity responsible for monitoring;
    f. development of a contingency plan (i.e., adaptive management);
    g. 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;
    h. implement riverbank protection/stabilization in areas that are experiencing instability, gravel bar protection/restoration, sand and gravel mine restoration;
    i. and establish a consultation process with appropriate Federal and State agencies to determine acceptable means of mitigation and success criteria.
7. Remove obsolete barriers, such as Poole's Bluff Sill, West Pearl lock and dam, and Bogue Chitto Sill to restore instream functions within the mainstem Pearl River as a form of partial mitigation for impacts to riverine functions within the project area.
8. Assess existing constrictions on flow and improve for flood control considerations (i.e., in stream debris-clean up, bridge and culvert inadequacy for flow, railway obstruction, etc.).
9. Include measures and features to promote aquatic organism passage throughout the project area, and ensure designs facilitate appropriate velocities for fish and turtles.
10. During low-flow periods, including droughts, sufficient flow should be maintained even if water levels fall below target pool elevations, matching the discharge from the Ross Barnett Reservoir.
11. 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. Develop plan to aid in sediment flushing.
12. 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. Since benthic communities can be at risk of impairment (Cattaneo et al. 2020), such a plan should include ecological objectives and operations should limit or avoid adverse impacts downstream.

13. 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 for addressing that potential issue.
14. Watershed, sediment, and water quality analysis within the Pearl River Basin is recommended, which may help identify and develop ecosystem restoration projects that could reduce flood risk throughout the basin. In addition, 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 (ER 1110-2-8154; engineer regulation on water quality).
15. 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.
16. 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.
17. 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 if it is determined necessary.
18. 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.

19. Creation and reforestation of a riparian zone along the toe of the levee 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.
20. 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.
21. A conservation easement, in perpetuity, should be recorded on the deed of any mitigation site.
22. The Service and other natural resource agencies should be coordinated with during the next planning and construction phases as project details are developed.
23. Loss of any flows and the resulting potential changes to water quality, including salinities, within the Mississippi Sound should be monitored. Details regarding water quality parameters and location should be developed with the LDWF Marine Fisheries staff.
24. Undeveloped portions of the floodplain serve to absorb and store storm run-off and reduce additional flood damages. 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. Floodplain ordinances could be an effective measure to avoid additional future flood damages throughout the Jackson metropolitan area.
25. Federal and state listed, and at-risk mussel and turtle species relocations should be conducted prior to dredging and construction activities.
26. The Service recommends continued consultation on federally protected species.

To ensure that fish and wildlife resources receive equal consideration with other project purposes, the Service recommends that important riverine habitats, their functions, values, and aquatic communities be conserved, protected, and restored where practicable to provide natural river habitats including flowing waters, heterogeneous microhabitats, and connectivity to backwaters and oxbow lakes. We also recommend important terrestrial habitats be conserved, protected, and restored.

Summary of Findings and Service Position

Executive Order 11988, Floodplain Management (May 1977), directs federal agencies to minimize adverse impacts and avoid development in floodplains, if practicable. This includes the 100-year floodplain in the study area. Executive Order 11990, Protection of Wetlands (May 1977), further directs federal agencies to avoid, to the extent possible, development in wetlands and to minimize the destruction or degradation of wetlands.

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 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 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 Alternative C as proposed in the Pearl River Basin, Mississippi, Federal Flood Risk Management Project, Rankin and Hinds Counties, Mississippi. 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 nine months of each year. Further, adverse impacts to natural resources are expected downstream as far as Copiah Creek (66 miles

downstream). 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 may mitigate impacts of the weir, but velocities would need to be confirmed and monitoring and adaptive management would be warranted.

2. Alternative C is the most damaging alternative for both terrestrial and aquatic resources. Alternative A1 would induce the least ecological damage while providing reduced flood damage. The CTO could provide flood protection with reduced impacts to terrestrial and aquatic resources, pending no major modifications (*i.e*., impoundment) to the Pearl River or its floodplain are included. However, the actual flood risk reduction benefits are not known because the alternatives did not feature such combinations, and the CTO is still being developed.

3. The Service has provided recommendations within the draft FWCA report that would aid in avoiding and minimizing impacts to fish and wildlife resources. Incorporation of those recommendations would aid in complying with this criterion. The CTO, although currently not proposing major modifications to the Pearl River or its floodplain, has not fully presented or finalized its plan or potential impacts. Currently, it states that an entity can construct features such as a weir or impoundment as presented in Alternative C. Such a provision is concerning for reasons mentioned above. A potentially feasible alternative to achieve avoidance and minimization while still meeting the project goals could include the proposed nonstructural solutions, Alternative A1, and portions of the CTO (pending project components do not include major modifications to the Pearl River or its floodplain). 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 is currently cooperating with the Corps in ongoing mitigation planning.

4. The Service notes inadequate time permitted to fully analyze impacts and determine proper mitigation measures for loss in riverine function and habitat for each alternative. Specifically, determining if previous impact analysis was sufficient and accurate, identifying appropriate mitigation for impacts, and analyzing compensatory mitigation is challenging for the time allotted. Time constraints necessitate the use of previous accomplishments to determine compensatory mitigation as best possible, but may not be adequate for such severe impacts to natural resources. Compensatory mitigation plans are ongoing, and specific tasks may not be available until after a draft EIS is developed.

5. There is a demonstrated need for flood protection within the Jackson area; however, the need for the proposed Alternative C 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 our recommendations be incorporated into the project plans to ensure compliance with the FWCA. Specific recommendations for the CTO will be provided when final design details and potential impacts are provided. The Service looks forward to our continued work with the Corps to address the flood risk reduction needs of Jackson and the surrounding area.

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Appendix I

Species List for the Pearl River Basin

(from *A Resource Inventory of the Pearl River Basin, Mississippi and Louisiana*)

APPENDIX I

MAMMALS

DIDELPHIDAE	
Opossum	*Didelphis marsupialis*
SORICIDAE	
Southeastern Shrew	*Sorex longirostris*
Short-tailed Shrew	*Blarina brevicauda*
Least Shrew	*Cryptotis parva*
TALPIDAE	
Eastern Mole	*Scalopus aquaticus howelli*
VESPERTILIONIDAE	
Southeastern Myotis	*Myotis austroriparius*
Eastern Pipistrel	*Pipistrellus subflavus*
Big Brown Bat	*Eptesicus fuscus*
Red Bat	*Lasiurus borealis*
Seminole Bat	*Lasiurus seminolus*
Hoary Bat	*Lasiurus cinereus*
Northern Yellow Bat	*Lasiurus intermedius*
Evening Bat	*Nycticeius humeralis*
Eastern Big-eared Bat	*Plecotus rafinesquii*
Mexican Free-tailed Bat	*Tadarida brasiliensis*
DASYPODIDAE	
Nine-banded Armadillo	*Dasypus novemcinctus*
LEPORIDAE	
Eastern Cottontail	*Sylvilagus floridanus*
Swamp Rabbit	*Sylvilagus aquaticus*
SCIURIDAE	
Eastern Gray Squirrel	*Sciurus carolinensis*
Eastern Fox Squirrel	*Sciurus niger*
Southern Flying Squirrel	*Glaucomys volans*
Eastern Chipmunk	*Tamias striatus*
CASTORIDAE	
American Beaver	*Castor canadensis*
CRICETIDAE	
Marsh Rice Rat	*Oryzomys palustris*
Eastern Harvest Mouse	*Reithrodontomys humulis*
Fulvous Harvest Mouse	*Reithrodontomys fulvescens*
White-footed Mouse	*Peromyscus leucopus*

APPENDIX I (cont'd)

CRICETIDAE (cont'd)	
Cotton Mouse	*Peromyscus gossypinus*
Golden Mouse	*Ochrotomys nuttalli*
Hispid Cotton Rat	*Sigmodon hispidus*
Eastern Wood Rat	*Neotoma floridana*
Pine Vole	*Pitymys pinetorom*
Muskrat	*Ondatra zibethicus*
MURIDAE	
Black Rat	*Rattus rattus*
Norway Rat	*Rattus norvegicus*
House Mouse	*Mus musculus*
CAPROMYIDAE	
Nutria	*Myocastor coypus*
CANIDAE	
Coyote	*Canis latrans*
Red Wolf	*Canis rufus*
Red Fox	*Vulpes fulva*
Gray Fox	*Urocyon cinereoargenteus*
URSIDAE	
American Black Bear	*Urus americanus*
PROCYONIDAE	
Raccoon	*Procyon lotor*
MUSTELIDAE	
Long-tailed Weasel	*Mustela frenata*
Mink	*Mustela vison*
Spotted Skunk	*Spilogale putorius*
Striped Skunk	*Mephitis mephitis*
River Otter	*Lutra canadensis*
FELIDAE	
Florida Panther	*Felis concolor coryi*
Bobcat	*Lynx rufus*
CERVIDAE	
White-tailed Deer	*Odocoileus virginianus*

APPENDIX I (cont'd)

BIRDS

GAVIIDAE	
Common Loon	*Gavia immer*
PODICIPEDIDAE	
Horned Grebe	*Podiceps auritus*
Eared Grebe	*Podiceps nigricollis*
Pied-billed Grebe	*Podilymbus podiceps*
PELECANIDAE	
White Pelican	*Pelecanus erythrorhynchos*
Brown Pelican	*Pelecanus occidentalis*
SULIDAE	
Gannet	*Morus bassanus*
PHALACROCORACIDAE	
Double-crested Cormorant	*Phalacrocorax auritus*
ANHINGIDAE	
Anhinga	*Anhinga anhinga*
FREGATIDAE	
Magnificent Frigatebird	*Fregata magnificens*
ARDEIDAE	
Great Blue Heron	*Ardea herodias*
Green Heron	*Butorides striatus*
Little Blue Heron	*Florida caerulea*
Cattle Egret	*Bubulcus ibis*
Reddish Egret	*Dichromanassa rufescens*
Great Egret	*Casmerodius albus*
Snowy Egret	*Egretta thula*
Louisiana Heron	*Hydranassa tricolor*
Black-crowned Night Heron	*Nyctiocorax nyctiocorax*
Yellow-crowned Night Heron	*Nyctanassa violacea*
Least Bittern	*Ixobrychus exilis*
American Bittern	*Botaurus lentiginosus*
CICONIIDAE	
Wood Stork	*Mycteria americana*
THRESKIORNITHIDAE	
Glossy Ibis	*Plegadis falcinellus*
White-faced Ibis	*Plegadis chihi*
White Ibis	*Eudocimus albus*

APPENDIX I (cont'd)

ANATIDAE	
Whistling Swan	Olor columbianus
Canada Goose	Branta canadensis
White-fronted Goose	Anser albifrons
Snow Goose	Chen caerulescens
Fulvous Whistling-Duck	Dendrocygna bicolor
Mallard	Anas platyrynchos
Black Duck	Anas rubripes
Mottled Duck	Anas fulvigula
Gadwall	Anas strepera
Pintail	Anas acuta
Green-winged Teal	Anas crecca
Blue-winged Teal	Anas discors
American Wigeon	Anas americana
Northern Shoveler	Anas clypeata
Wood Duck	Aix sponsa
Redhead	Aythya americana
Ring-necked Duck	Aythya collaris
Canvasback	Aythya valisineria
Greater Scaup	Aythya marila
Lesser Scaup	Aythya affinis
Common Goldeneye	Bucephala clangula
Bufflehead	Bucephala albeola
Oldsquaw	Clangula hyemalis
White-winged Scoter	Melanitta deglandi
Surf Scoter	Melanitta perspicillata
Black Scoter	Melanitta nigra
Ruddy Duck	Oxyura jamaicensis
Hooded Merganser	Lophodytes cucullatus
Common Merganser	Mergus merganser
Red-breasted Merganser	Mergus serrator
CATHARTIDAE	
Turkey Vulture	Cathartes aura
Black Vulture	Coragyps atratus
ACCIPITRIDAE	
Swallow-tailed Kite	Elanoides forficatus
Mississippi Kite	Ictinia mississippiensis
Sharp-shinned Hawk	Accipiter striatus
Cooper's Hawk	Accipiter cooperi
Red-tailed Hawk	Buteo jamaicensis
Red-shouldered Hawk	Buteo lineatus
Broad-winged Hawk	Buteo platypterus
Harris' Hawk	Parabuteo unicinctus
Golden Eagle	Aquila chrysaetos
Bald Eagle	Haliaeetus leucocephalus
Marsh Hawk	Circus cyaneus
PANDIONIDAE	
Osprey	Pandion haliaetus

APPENDIX I (cont'd)

FALCONIDAE	
Arctic Peregrine Falcon	Falco peregrinus tundrius
Merlin	Falco columbarius
American Kestrel	Falco sparverius
PHASIANIDAE	
Bobwhite	Colinus virginianus
MELEAGRIDIDAE	
Turkey	Meleagris gallopavo
GRUIDAE	
Sandhill Crane	Grus canadensis
RALLIDAE	
King Rail	Rallus elegans
Clapper Rail	Rallus longirostris
Virginia Rail	Rallus limnicola
Sora	Porzana carolina
Yellow Rail	Coturnicops noveboracensis
Black Rail	Laterallus jamaicensis
Purple Gallinule	Porphyrula martinica
Common Gallinule	Gallinula chloropus
American Coot	Fulica americana
CHARADRIIDAE	
Semipalmated Plover	Charadrius semipalmatus
Piping Plover	Charadrius melodus
Snowy Plover	Charadrius alexandrinus
Wilson's Plover	Charadrius wilsonia
Killdeer	Charadrius vociferus
American Golden Plover	Pluvialus dominica
Black-bellied Plover	Pluvialus squatarola
SCOLOPACIDAE	
Ruddy Turnstone	Arenaria interpres
American Woodcock	Philohela minor
Common Snipe	Capella gallinago
Whimbrel	Numenius phaeopus
Upland Sandpiper	Bartramia longicauda
Spotted Sandpiper	Actitis macularia
Solitary Sandpiper	Tringa solitaria
Greater Yellowlegs	Tringa melanoleucas
Lesser Yellowlegs	Tringa flavipes
Willet	Catoptrophorus semipalmatus
Red Knot	Calidris canutus
Pectoral Sandpiper	Calidris melanotos
White-rumped Sandpiper	Calidris fuscicollis
Least Sandpiper	Calidris minutilla
Dunlin	Calidris alpina
Semipalmated Sandpiper	Calidris pusillus

SCOLOPACIDAE (cont'd)	
Western Sandpiper	*Calidris mauri*
Sanderling	*Calidris alba*
Short-billed Dowitcher	*Limnodromus griseus*
Long-billed Dowitcher	*Limnodromus scolopaceus*
Stilt Sandpiper	*Micropalama himantopus*
Buff-breasted Sandpiper	*Tryngites subruficollis*
Marbled Godwit	*Limosa fedoa*
Hudsonian Godwit	*Limosa haemastica*
RECURVIROSTRIDAE	
American Avocet	*Recurvirostra americana*
Black-necked Stilt	*Himantopus mexicanus*
PHALAROPODIDAE	
Wilson's Phalarope	*Steganopus tricolor*
Northern Phalarope	*Lobipes lobatus*
LARIDAE	
Herring Gull	*Larus argentatus*
Ring-billed Gull	*Larus delawarensis*
Laughing Gull	*Larus atricilla*
Bonaparte's Gull	*Larus philadelphia*
Black-legged Kittiwake	*Rissa tridactyla*
Gull-billed Tern	*Gelochelidon nilotica*
Forster's Tern	*Sterna forsteri*
Common Tern	*Sterna hirundo*
Sooty Tern	*Sterna fuscata*
Least Tern	*Sterna albifrons*
Royal Tern	*Sterna maximus*
Sandwich Tern	*Sterna sandvicensis*
Caspian Tern	*Sterna caspia*
Black Tern	*Chlidonias niger*
RYNCHOPIDAE	
Black Skimmer	*Rynchops niger*
COLUMBIDAE	
Rock Dove	*Columba livia*
White-winged Dove	*Zenaida asiatica*
Mourning Dove	*Zenaida macroura*
Ground Dove	*Columbina passerina*
CUCULIDAE	
Yellow-billed Cuckoo	*Coccyzus americanus*
Black-billed Cuckoo	*Coccyzus erythropthalmus*
Groove-billed Ani	*Crotophaga sulcirostris*
TYTONIDAE	
Barn Owl	*Tyto alba*

APPENDIX I (cont'd)

STRIGIDAE	
Screech Owl	Otus asio
Great Horned Owl	Bubo virginianus
Burrowing Owl	Athene cunicularia
Barred Owl	Strix varia
Long-eared Owl	Asio otus
Short-eared Owl	Asio flammeus
Saw-whet Owl	Aegolius acadicus
CAPRIMULGIDAE	
Chuck-wills-widow	Caprimulgus carolinensis
Whip-poor-will	Caprimulgus vociferus
Common Nighthawk	Chordeiles minor
APODIDAE	
Chimney Swift	Chaetura pelagica
TROCHILIDAE	
Ruby-throated Hummingbird	Archilochus colubris
ALCEDINIDAE	
Belted Kingfisher	Megaceryle alcyon
PICIDAE	
Common Flicker	Colaptes auratus
Pileated Woodpecker	Dryocopus pileatus
Red-bellied Woodpecker	Melanerpes carolinus
Red-headed Woodpecker	Melanerpes erythrocephalus
Yellow-bellied Sapsucker	Sphyrapicus varius
Hairy Woodpecker	Picoides villosus
Downy Woodpecker	Picoides pubescens
Red-cockaded Woodpecker	Picoides borealis
Ivory-billed Woodpecker*	Campephilus principalis
TYRANNIDAE	
Eastern Kingbird	Tyrannus tyrannus
Western Kingbird	Tyrannus verticalis
Scissor-tailed Flycatcher	Muscivora forficata
Great-crested Flycatcher	Myiarchus crinitus
Eastern Phoebe	Sayornis phoebe
Say's Phoebe	Sayornis saya
Acadian Flycatcher	Empidonax virescens
Eastern Wood Pewee	Contopus virens
Olive-sided Flycatcher	Nuttallornis borealis
Vermilion Flycatcher	Pyrocephalus rubinus
ALAUDIDAE	
Horned Lark	Eremophila alpestris

* No verified reports but Basin is within historical range of species.

APPENDIX I (cont'd)

HIRUNDINIDAE	
Tree Swallow	*Iridoprocne bicolor*
Bank Swallow	*Riparia riparia*
Rough-winged Swallow	*Stelgidopteryx ruficollis*
Barn Swallow	*Hirundo rustica*
Cliff Swallow	*Petrochelidon pyrrhonota*
Purple Martin	*Progne subis*
CORVIDAE	
Blue Jay	*Cyanocitta cristata*
Common Crow	*Corvus brachyrhynchos*
Fish Crow	*Corvus ossifragus*
PARIDAE	
Carolina Chickadee	*Parus carolinensis*
Tufted Titmouse	*Parus bicolor*
SITTIDAE	
White-breasted Nuthatch	*Sitta carolinensis*
Red-breasted Nuthatch	*Sitta canadensis*
Brown-headed Nuthatch	*Sitta pusilla*
CERTHIIDAE	
Brown Creeper	*Certhia familiaris*
TROGLODYTIDAE	
House Wren	*Troglodytes aedon*
Winter Wren	*Troglodytes troglodytes*
Bewick's Wren	*Thryomanes bewickii*
Carolina Wren	*Thryothorus ludovicianus*
Long-billed Marsh Wren	*Cistothorus palustris*
Short-billed Marsh Wren	*Cistothorus platensis*
MIMIDAE	
Mockingbird	*Mimus polyglottos*
Gray Catbird	*Dumetella carolinesis*
Brown Thrasher	*Toxostoma rufum*
TURDIDAE	
American Robin	*Turdus migratorius*
Wood Thrush	*Hylocichla mustelina*
Hermit Thrush	*Catharus guttata*
Swainson's Thrush	*Catharus ustulatus*
Gray-cheeked Thrush	*Catharus minima*
Veery	*Catharus fuscescens*
Eastern Bluebird	*Sialia sialis*
SYLVIIDAE	
Blue-gray Gnatcatcher	*Polioptila caerulea*
Golden-crowned Kinglet	*Regulus satrapa*
Ruby-crowned Kinglet	*Regulus calendula*

APPENDIX I (cont'd)

MOTACILLIDAE	
Water Pipit	*Anthus spinoletta*
Sprague's Pipit	*Anthus spragueii*
BOMBYCILLIDAE	
Cedar Waxwing	*Bombycilla cedorum*
LANIIDAE	
Loggerhead Shrike	*Lanius ludovicianus*
STURNIDAE	
Starling	*Sturnus vulgaris*
VIREONIDAE	
White-eyed Vireo	*Vireo griseus*
Bell's Vireo	*Vireo bellii*
Yellow-throated Vireo	*Vireo flavifrons*
Solitary Vireo	*Vireo solitarius*
Red-eyed Vireo	*Vireo olivaceus*
Philadelphia Vireo	*Vireo philadelphicus*
Warbling Vireo	*Vireo gilvus*
PARULIDAE	
Black-and-white Warbler	*Mniotilta varia*
Prothonotary Warbler	*Protonotaria citrea*
Swainson's Warbler	*Limnothlypis swainsonii*
Worm-eating Warbler	*Helmitheros vermivorus*
Golden-winged Warbler	*Vermivora chrysoptera*
Blue-winged Warbler	*Vermivora pinus*
Bachman's Warbler*	*Vermivora bachmanii*
Tennessee Warbler	*Vermivora peregrina*
Orange-crowned Warbler	*Vermivora celata*
Nashville Warbler	*Vermivora ruficapilla*
Northern Parula	*Parula americana*
Yellow Warbler	*Dendroica petechia*
Magnolia Warbler	*Dendroica magnolia*
Cape May Warbler	*Dendroica tigrina*
Black-throated Blue Warbler	*Dendroica caerulescens*
Yellow-rumped Warbler	*Dendroica coronata*
Black-throated Green Warbler	*Dendroica virens*
Cerulean Warbler	*Dendroica cerulea*
Blackburnian Warbler	*Dendroica fusca*
Yellow-throated Warbler	*Dendroica dominica*
Chestnut-sided Warbler	*Dendroica pensylvanica*
Bay-breasted Warbler	*Dendroica castanea*
Blackpoll Warbler	*Dendroica striata*
Pine Warbler	*Dendroica pinus*
Kirtland's Warbler	*Dendroica kirtlandii*
Prairie Warbler	*Dendroica discolor*
Palm Warbler	*Dendroica palmarum*

* No verified reports but Basin is within historical range of species.

APPENDIX I (cont'd)

PARULIDAE (cont'd)	
Overbird	*Seiurus aurocapillus*
Northern Waterthrush	*Seiurus noveboracensis*
Louisiana Waterthrush	*Seiurus motacilla*
Kentucky Warbler	*Oporornis formusus*
Connecticut Warbler	*Oporornis agilis*
Mourning Warbler	*Oporornis philadelphia*
Common Yellowthroat	*Geothlypis trichas*
Yellow-breasted Chat	*Icteria virens*
Hooded Warbler	*Wilsonia citrina*
Wilson's Warbler	*Wilsonia pusilla*
Canada Warbler	*Wilsonia canadensis*
American Redstart	*Setophaga ruticilla*
PLOCEIDAE	
House Sparrow	Passer domesticus
ICTERIDAE	
Bobolink	*Dolichonyz oryzivorus*
Eastern Meadowlark	*Sturnella magna*
Western Meadowlark	*Sturnella neglecta*
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*
Red-winged Blackbird	*Agelaius phoeniceus*
Orchard Oriole	*Icterus spurius*
Northern Oriole	*Icterus galbula*
Rusty Blackbird	*Euphagus carolinus*
Brewer's Blackbird	*Euphagus cyanocephalus*
Boat-tailed Grackle	*Quiscalus mexicanus*
Common Grackle	*Quiscalus quiscula*
Brown-headed Cowbird	*Molothrus ater*
THRAUPIDAE	
Western Tanager	*Piranga ludoviciana*
Scarlet Tanager	*Piranga olivacea*
Summer Tanager	*Piranga rubra*
FRINGILLIDAE	
Cardinal	*Cardinalis cardinalis*
Rose-breasted Grosbeak	*Pheucticus ludovicianus*
Black-headed Grosbeak	*Pheucticus melanocephalus*
Blue Grosbeak	*Guiraca caerulea*
Indigo Bunting	*Passerina cyanea*
Painted Bunting	*Passerina ciris*
Dickcissel	*Spiza americana*
Evening Grosbeak	*Hesperiphona vespertina*
Purple Finch	*Carpodacus purpureus*
Pine Siskin	*Carduelis spinus*
American Goldfinch	*Carduelis tristis*
Rufous-sided Towhee	*Pipilo erythrophthalmus*
Lark Bunting	*Calamospiza melanocorys*
Savannah Sparrow	*Passerculus sandwichensis*

APPENDIX I (cont'd)

FRINGILLIDAE (cont'd)

Grasshopper Sparrow	*Ammodramus savannarum*
Sharp-tailed Sparrow	*Ammospiza caudacuta*
Seaside Sparrow	*Ammospiza maritima*
Vesper Sparrow	*Pooecetes gramineus*
Lark Sparrow	*Chondestes grammacus*
Bachman's Sparrow	*Aimophila aestivalis*
Dark-eyed Junco	*Junco hyemalis*
Chipping Sparrow	*Spizella passerina*
Clay-colored Sparrow	*Spizella pallida*
Field Sparrow	*Spizella pusilla*
Harris' Sparrow	*Zonotrichia querula*
White-crowned Sparrow	*Zonotrichia leucophrys*
White-throated Sparrow	*Zonotrichia albicollis*
Fox Sparrow	*Passerella iliaca*
Lincoln's Sparrow	*Melospiza lincolnii*
Swamp Sparrow	*Melospiza georgiana*
Song Sparrow	*Melospiza melodia*
Lapland Longspur	*Calcarius lapponicus*

APPENDIX I (cont'd)

REPTILES

ALLIGATORIDAE	
American Alligator	*Alligator mississippiensis*
CHELYDRIDAE	
Snapping Turtle	*Chelydra serpentina*
Alligator Snapping Turtle	*Macroclemys temmincki*
KINOSTERNIDAE	
Common Musk Turtle	*Sternotherus odoratus*
Stripe-necked Musk Turtle	*Sternotherus minor peltifer*
Razor-backed Musk Turtle	*Sternotherus carinatus*
Eastern Mud Turtle	*Kinosternon subrubrum subrubrum*
Mississippi Mud Turtle	*Kinosternon subrubrum hippocrepis*
EMYDIDAE	
Alabama Map Turtle	*Graptemys pulchra*
Mississippi Map Turtle	*Graptemys kohni*
Ringed Sawback	*Graptemys oculifera*
Mississippi Diamondback Terrapin	*Malaclemys terrapin pileata*
Southern Painted Turtle	*Chrysemys picta dorsalis*
Slider	*Chrysemys concinna hieroglyphica*
Mobile Cooter	*Chrysemys concinna mobilensis*
Missouri Slider	*Chrysemys floridana hoyi*
Red-eared Pond Slider	*Chrysemys scripta elegans*
Yellow-bellied Turtle	*Chrysemys scripta scripta*
Three-toed Box Turtle	*Terrapene carolina triunguis*
Eastern Chicken Turtle	*Dierochelys reticularia reticularia*
TESTUDINIDAE	
Gopher Tortoise	*Gopherus polyphemus*
TRIONYCHIDAE	
Gulf Coast Smooth Softshell	*Trionyx muticus calvatus*
Gulf Coast Spiney Softshell	*Trionyx siniferus asperus*
IGUANIDAE	
Green Anole	*Anolis carolinensis carolinensis*
Northern Fence Lizard	*Sceloporus undulatus hyacinthinus*
Southern Fence Lizard	*Sceloporus undulatus undulatus*
SCINCIDAE	
Ground Skink	*Scincella lateralis*
Five-lined Skink	*Eumeces faciatus*
Broad-headed Skink	*Eumeces laticeps*
Southeastern Five-lined Skink	*Eumeces inexpectatus*
Southern Coal Skink	*Eumeces anthracinus pluvialus*

APPENDIX I (cont'd)

TEIIDAE	
Six-lined Racerunner	Cnemidophorus sexlineatus sexlineatus
ANGUIDAE	
Eastern Glass Lizard	Ophisaurus ventralis
Eastern Slender Glass Lizard	Ophisaurus attenuatus longicaudus
COLUBRIDAE	
Banded Water Snake	Natrix fasciata fasciata
Broad-banded Water Snake	Natrix fasciata confluens
Gulf Coast Salt Marsh Snake	Natrix fasciata clarki
Green Water Snake	Natrix cyclopion cyclopion
Gulf Coast Glossy Water Snake	Natrix rigida sinicola
Delta Glossy Water Snake	Natrix rigida deltae
Midland Water Snake	Nerodia sipedon pleuralis
Yellow-bellied Water Snake	Nerodia erythrogaster flavigaster
Diamondback Water Snake	Nerodia rhombifera rhombifera
Queen Snake	Regina septemvittata
Eastern Garter Snake	Thamnophis sirtalis sirtalis
Eastern Ribbon Snake	Thamnophis sauritus sauritus
Western Ribbon Snake	Thamnophis proximus proximus
Rough Earth Snake	Virginia striatula
Western Smooth Earth Snake	Virginia valeriae elegans
Yellow-lipped Snake	Rhadinaea flavitata
Northern Red-bellied Snake	Storeria occipitomaculata
Midland Brown Snake	Storeria dekayi wrighttorum
Marsh Brown Snake	Storeria dekayi limnetes
Eastern Hognose Snake	Heterodon platyrhinos
Midwest Worm Snake	Carophophis amoenus helenae
Mississippi Ringneck Snake	Diadophis punctatus stictogenys
Rough Green Snake	Opheodrys aestivus
Rainbow Snake	Farancia erytrogramma erytrogramma
Western Mud Snake	Farancia abacura reinwardti
Southern Black Racer	Coluber constrictor priapus
Eastern Coachwhip	Masticophis flagellum flagellum
Eastern Indigo Snake	Drymarchon corais couperi
Black Pine Snake	Pituophis melanoleucus lodingi
Gray Rat Snake	Elaphe obsoleta spiloides
Corn Snake	Elaphe guttata guttata
Northern Scarlet Snake	Cemophora coccinea copei
Scarlet Kingsnake	Lampropeltis triangulum elapsoides
Pale Milk Snake	Lampropeltis triangulum multistrata
Mole Snake	Lampropeltis calligaster rhombomaculta
Speckled Kingsnake	Lampropeltis getulus holbrooki
Southeastern Crowned Snake	Tantilla coronata
VIPERIDAE	
Western Cottonmouth	Agkistrodon piscivorus leucostoma
Southern Copperhead	Agkistrodon contortrix contortrix
Western Pygmy Rattlesnake	Sistrurus miliarius streckeri

VIPERIDAE (cont'd)	
Dusky Pygmy Rattlesnake	*Sistrurus miliarius barbouri*
Canebrake Rattlesnake	*Crotalus horridus atricaudatus*
ELAPIDAE	
Eastern Coral Snake	*Micrurus fulvius fulvius*

APPENDIX I (cont'd)

AMPHIBIANS

SIRENIDAE	
Western Lesser Siren	Siren intermedia nettingi
AMPIUMIDAE	
Three-toed Amphiuma	Amphiuma tridactylum
Two-toed Amphiuma	Amphiuma means
NECTURIDAE	
Gulf Coast Waterdog	Necturus beyeri
Alabama Waterdog	Necturus alabamensis
SALAMANDRIDAE	
Central Newt	Notophthalmus viridescens louisianensis
AMBYSTOMATIDAE	
Mole Salamander	Ambystoma talpoideum
Small-mouthed Salamander	Ambystoma texanum
Eastern Tiger Salamander	Ambystoma tigrinum tigrinum
Spotted Salamander	Ambystoma maculatum
Marbled Salamander.	Ambystoma spacum
PLETHODONTIDAE	
Spotted Dusky Salamander	Desmoganthus fuscus conanti
Southern Dusky Salamander	Desmoganthus auriculatus
Southern Red Salamander	Pseudotriton ruber vioscai
Gulf Coast Mud Salamander	Pseudotriton montanus flavissimus
Slimy Salamander	Plethodon glutinosus glutinosus
Zig Zag Salamander	Plethodon dorsalis dorsalis
Four-toed Salamander	Hemidactylium scutatum
Southern Two-lined Salamander	Eurycea bislineata cirrigera
Three-lined Salamander	Eurycea longicauda guttolineata
Dwarf Salamander	Eurycea quadridigitata
PELOBATIDAE	
Eastern Spadefoot Toad	Scaphipus holbrooki holbrooki
MICROHYLIDAE	
Eastern Narrow-mouthed Toad	Gastrophryne carolinensis
BUFONIDAE	
American Toad	Bufo americanus americanus
Southern Toad	Bufo terrestris
Fowler's Toad	Bufo woodhousei fowleri
Oak Toad	Bufo quercicus
HYLIDAE	
Barking Treefrog	Hyla gratiosa
Northern Spring Peeper	Hyla crucifer crucifer

APPENDIX I (cont'd)

HYLIDAE (cont'd)	
Green Treefrog	*Hyla cinerea*
Western Bird-voiced Treefrog	*Hyla avivoca avivoca*
Squirrel Treefrog	*Hyla squirella*
Pine Woods Treefrog	*Hyla femoralis*
Gray Treefrog	*Hyla versicolor*
Gray Treefrog	*Hyla chrysoscelis*
Ornate Chorus Frog	*Pseudacris ornata*
Southern Chorus Frog	*Pseudacris nigrita nigrita*
Upland Chorus Frog	*Pseudacris triseriata feriarum*
Northern Cricket Frog	*Acris crepitans crepitans*
Southern Cricket Frog	*Acris gryllus gryllus*
RANIDAE	
Bronze Frog	*Rana climitans climitans*
Pig Frog	*Rana grylio*
Bullfrog	*Rana catesbeiana*
Southern Leopard Frog	*Rana utricularia*
Pickeral Frog	*Rana palustris*
Northern Crawfish Frog	*Rana areolata circulosa*
Dusky Gopher Frog	*Rana areolata sevosa*

APPENDIX I (cont'd)

FISHES

PETROMYZONTIDAE	
Chestnut Lamprey	*Ichthyomyzon castaneus*
Southern Brook Lamprey	*Ichthyomyzon gagei*
Least Brook Lamprey	*Okkelbergia aepyptera*
ACIPENSERIDAE	
Atlantic Sturgeon	*Acipenser oxyrhynchus*
POLYODONTIDAE	
Paddlefish	*Polyodon spathula*
AMIIDAE	
Bowfin	*Amia calva*
LEPISOSTEIDAE	
Spotted Gar	*Lepisosteus oculatus*
Longnose Gar	*Lepisosteus osseus*
Alligator Gar	*Lepisosteus spathula*
ELOPIDAE	
Tarpon	*Megalops atlantica*
CLUPEIDAE	
Alabama Shad	*Alosa alabamae*
Largescale Menhaden	*Brevoortia patronus*
Skipjack Herring	*Alosa chrysochloris*
Gizzard Shad	*Dorosoma cepedianum*
Threadfin Shad	*Dorosoma petenense*
ENGRAULIADAE	
Bay Anchovy	*Anchoa mitchilli*
ESOCIDAE	
Grass Pickerel	*Esox americanus*
Chain Pickerel	*Esox niger*
HIODONTIDAE	
Mooneye	*Hiodon tergisus*
CATOSTOMIDAE	
Quillback	*Carpiodes cyprinus*
Highfin Carpsucker	*Carpiodes velifer*
Blue Sucker	*Cycleptus elongatus*
Creek Chubsucker	*Erimyzon oblongus*
Lake Chubsucker	*Erimyzon sucetta*
Sharpfin Chubsucker	*Erimyzon tenuis*
Hogsucker	*Hypentelium nigricans*
Smallmouth Buffalo	*Ictiobus bubalus*

APPENDIX I (cont'd)

SYNGNATHIDAE
- Gulf Pipefish — *Syngnathus scovelli*

CYPRINODONTIDAE
- Northern Studfish — *Fundulus catenatus*
- Golden Topminnow — *Fundulus chrysotus*
- Blackstripe Topminnow — *Fundulus notatus*
- Starhead Minnow — *Fundulus notti*
- Blackspotted Topminnow — *Fundulus olivaceus*

POECILIIDAE
- Mosquitofish — *Gambusia affinis*
- Least Killifish — *Heterandria formosa*
- Sailfin Molly — *Poecilia latipinna*

APHREDODERIDAE
- Pirate Perch — *Aphredoderus sayanus*

ATHERINIDAE
- Brook Silverside — *Labidesthes sicculus*
- Tidewater Silverside — *Menidia beryllina*

MUGILIDAE
- Striped Mullet — *Mugil cephalus*

PERCICHTHYIDAE
- Yellow Bass — *Morone mississippiensis*
- Striped Bass — *Morone saxatilis*

CENTRARCHIDAE
- Rockbass — *Ambloplites rupestris*
- Flier — *Centrarchus macropterus*
- Banded Pygmy Sunfish — *Elassoma zonatum*
- Warmouth — *Chaenobryttus gulosus*
- Green Sunfish — *Lepomis cyanellus*
- Orangespotted Sunfish — *Lepomis humilis*
- Bluegill — *Lepomis macrochirus*
- Dollar Sunfish — *Lepomis marginatus*
- Longear Sunfish — *Lepomis megalotis*
- Redear Sunfish — *Lepomis microlophus*
- Spotted Sunfish — *Lepomis punctatus*
- Bantam Sunfish — *Lepomis symmetricus*
- Spotted Bass — *Micropterus punctulatus*
- Largemouth Bass — *Micropterus salmoides*
- White Crappie — *Pomoxis annularis*
- Black Crappie — *Pomoxis nigromaculatus*

PERCIDAE
- Crystal Darter — *Ammocrypta asperella*
- Naked Sand Darter — *Ammocrypta beani*
- Scaly Sand Darter — *Ammocrypta vivax*

APPENDIX I (cont'd)

CATOSTOMIDAE (cont'd)	
Spotted Sucker	*Minytrema melanops*
River Redhorse	*Moxostoma carinatum*
Blacktail Redhorse	*Moxostoma poecilurum*
CYPRINIDAE	
Carp	*Cyprinus carpio*
Silverjaw Minnow	*Ericymba buccata*
Cypress Minnow	*Hybognathus hayi*
Silvery Minnow	*Hybognathus nuchalis*
Speckled Chub	*Hybopsis aestivalis*
Bigeye Chub	*Hybopsis amblops*
Silver Chub	*Hybopsis storeriana*
Bluehead Chub	*Nocomis leptocephalus*
Golden Shiner	*Notemigonus crysoleucas*
Emerald Sniner	*Notropis atherinoides*
Bluntface Shiner	*Notropis camprus*
Ironcolor Shiner	*Notropis chalybaeus*
Common Shiner	*Notropis chrysocephalus*
Longnose Shiner	*Notropis longirostris*
Taillight Shiner	*Notropis maculatus*
Rosyfin Shiner	*Notropis roseipinnis*
Flagfin Shiner	*Notropis signipinnis*
Weed Shiner	*Notropis texanus*
Blacktail Shiner	*Notropis venustus*
Mimic Shiner	*Notropis volucellus*
Bluenose Shiner	*Notropis welaka*
Pugnose Minnow	*Opsopoeodus emiliae*
Bluntnose Minnow	*Pimephales notatus*
Bullhead Minnow	*Pimephales vigilax*
Creek Chub	*Semotilus atromaculatus*
ARIIDAE	
Sea Catfish	*Arius felis*
ICTALURIDAE	
Blue Catfish	*Ictalurus furcatus*
Black Bullhead	*Ictalurus melas*
Yellow Bullhead	*Ictalurus natalis*
Channel Catfish	*Ictalurus punctatus*
Black Madtom	*Noturus funebris*
Tadpole Madtom	*Noturus gyrinus*
Speckled Madtom	*Noturus leptacanthus*
Brindled Madtom	*Noturus miurus*
Frecklebelly Madtom	*Noturus munitus*
Freckled Madtom	*Noturus nocturnus*
Flathead Catfish	*Pylodictis olivaris*
ANGUILLIDAE	
American Eel	*Anguilla rostrata*
BELONIDAE	
Atlantic Needlefish	*Strongylura marina*

APPENDIX I (cont'd)

MUSSELS

AMBLEMIDAE

Amblema plicata perplicata
Fusconaia ebena
Fusconaia cerina
Fusconaia rubida
Fusconaia chickasawhensis
Plectomerus dombeyanus
Quadrula apiculata aspera
Quadrula pustulosa
Quadrula refulgens
Quadrula mortoni
Tritogonia verrucosa
Megalonaias nervosa

UNIONIDAE

Elliptio crassidens crassidens
Uniomerus tetralasmus
Uniomerus declivus
Anodonta imbecillis
Anodonta grandis corpulenta
Lasmigonia complanata
Glebula rotundata
Lampsilis teres teres
Lampsilis teres anodontoides
Lampsilis straminea daibornensis
Leptodea fragilis
Potamilus purpuratus
Ligumia subrostrata
Obovaria jacksoniana
Obovaria unicolor
Villosa lienosa lienosa
Obliquaria reflexa

APPENDIX I (cont'd)

PLANTS

PINACEAE	
Loblolly Pine	*Pinus taeda*
Longleaf Pine	*Pinus palustris*
Shortleaf Pine	*Pinus echinata*
Slash Pine	*Pinus elliottii*
TAXODIACEAE	
Bald Cypress	*Taxodium distichum*
TYPHACEAE	
cattail	*Typha sp.*
POTAMOGENTONACEAE	
pondweed	*Pontamogeton sp.*
RUPPIACEAE	
Widgeon Grass	*Ruppia maritima*
NAJADACEAE	
Southern Naiad	*Najas guadalupensis*
ALISMATACEAE	
arrowhead	*Sagittaria sp.*
Bulltongue	*Sagittaria lancifolia*
HYDROCHARITACEAE	
Wild Celery	*Vallisneria americana*
POACEAE	
Bermuda Grass	*Cynodon dactylon*
bluestem	*Andropogon sp.*
cordgrass	*Spartina sp.*
Big Cordgrass	*Spartina cynosuroides*
Saltmeadow Cordgrass	*Spartina alterniflora*
Corn	*Zea mays*
Dallis Grass	*Paspalum dialatatum*
fescue	*Festuca sp.*
Maidencane	*Panicum hemitomon*
Sorghrum	*Sorghrum vulgare*
Wild Millet	*Echinochloa walteri*
CYPERACEAE	
Sawgrass	*Cladium jamaicensis*
Southern Bullrush	*Scirpus californicus*
ARACEAE	
Golden Club	*Orontium aquaticum*
peltandra	*Peltandra sp.*

APPENDIX I (cont'd)

LEMNACEAE	
duckweed	_Lemna sp._
PONTEDERIACEAE	
Pickerelweed	_Pontederia cordata_
Water Hyacinth	_Eichhornia crassipes_
JUNCACEAE	
Needle Rush	_Juncus roemerianus_
LILIACEAE	
smilax	_Smilax sp._
SALICACEAE	
Black Willow	_Salix nigra_
JUGLANDACEAE	
hickory	_Carya sp._
Bitter Pecan	_Carya aquatica_
Bitternut Hickory	_Carya cordiformis_
Shagbark Hickory	_Carya ovata_
Swamp Hickory	_Carya leiodermis_
FAGACEAE	
Blackjack Oak	_Quercus marilandica_
Laurel Oak	_Quercus laurifolia_
Northern Red Oak	_Quercus rubra_
Nuttall Oak	_Quercus nuttallii_
Overcup Oak	_Quercus lyrata_
Post Oak	_Quercus stellata_
Scrub Oak	_Quercus ilicifolia_
Shumard Oak	_Quercus shumardii_
Southern Red	_Quercus falcata_
Swamp Chestnut Oak	_Quercus michauxii_
Water Oak	_Quercus nigra_
Willow Oak	_Quercus phellos_
ULMACEAE	
elm	_Ulmus sp._
American Elm	_Ulmus americana_
Slippery Elm	_Ulmus rubra_
Winged Elm	_Ulmus alata_
Sugarberry	_Celtis laevigata_
AMARANTHACEAE	
Alligator Weed	_Alternanthera philoxeroides_
CERATOPHYLLACEAE	
Coontail	_Ceratophyllum demersum_

CABOMACEAE	
Fanwort	*Cabomba caroliniana*
MAGNOLIACEAE	
Sweetbay	*Magnolia virginiana*
Yellow Poplar	*Liridendron tulipifera*
HAMAMELIDACEAE	
Sweetgum	*Liquidambar styraciflua*
PLATANACEAE	
Sycamore	*Platanus occidentalis*
ROSACEAE	
blackberry	*Rubus sp.*
Black Cherry	*Prunus serotina*
FABACEAE	
lespedeza	*Lespedeza sp.*
Redbud	*Cercis canadensis*
Sericea	*Lespedeza cuneata*
Soybean	*Glycine max*
ANACARDIACEAE	
sumac	*Rhus sp.*
Poison Oak	*Rhus toxicdendron*
ACERACEAE	
Box Elder	*Acer negundo*
Red Maple	*Acer rubrum*
Drummond Red Maple	*Acer rubrum* var. *drummondii*
MALVACEAE	
Cotton	*Gossypium hirsutum*
Rose Mallow	*Hibiscus militaris*
VIOLACEAE	
violets	*Viola sp.*
NYSSACEAE	
Tupelo Gum	*Nyssa aquatica*
CORNACEAE	
dogwood	*Cornus sp.*
Flowering Dogwood	*Cornus florida*
Roughleaf Dogwood	*Cornus drummondii*
ERICACEAE	
Sourwood	*Oxydendrum arboreum*

APPENDIX I (cont'd)

EBENACEAE	
Persimmon	*Diospyrus virginiana*
OLEACEAE	
Green Ash	*Fraxinus pennsylvanica*
GENTIANACEAE	
Pennywort	*Obolaria virginica*
LENTIBULARIACEAE	
bladderwort	*Utricularia sp.*
RUBIACEAE	
Buttonbush	*Cephalanthus occidentalis*
CAPRIFOLIACEAE	
honeysuckle	*Lonicera sp.*
ASTERACEAE	
asters	*Aster sp.*
goldenrod	*Solidago sp.*
ragweed	*Ambrosia sp.*
Bitterweed	*Helenium amarum*

Appendix 2

HEP Analysis

Evaluation Species and AAHUs

Evaluation Species	Alternative C
Barred owl	-2655
Black crappie	-1,221.05
Bluegill	1,083.83
Brown thrasher	66.29
Channel catfish	1,191.59
Common carp	-1,232.72
Eastern meadowlark	-285.79
Gray squirrel	-2733
Great blue heron	908.41
Great egret	-182.53
Largemouth bass	1,266.56
Redear sunfish	1,080.84
Slider turtle	641.06
Swamp rabbit	-3379
White crappie	1,248.21
Wood duck	409.86

Note: swamp rabbit highest loss (-3379 AAHUs), mixed forested wetlands, mixed scrub-shrub wetlands, palustrine. Squirrel (-2733 AAHUs) upland forest/scrub-shrub wetlands. Common carp (-1232.72 AAHUs) riverine. Largemouth bass (1266.56 AAHUs) lacustrine/open water.

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

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

Note: HSI Values for evaluation species taken from HEP.

U.S. Fish and Wildlife Service Coordination Act Report Recommendations and U.S. Army Corps of Engineers Responses

To ensure that fish and wildlife resources receive equal consideration with other project purposes, the Service recommends that important riverine habitats, their functions, values, and aquatic communities be conserved, protected, and restored where practicable to provide natural river habitats including flowing waters, heterogeneous microhabitats, and connectivity to backwaters and oxbow lakes. We also recommend important terrestrial habitats be conserved, protected, and restored. The Service recommends the following planning objectives be adopted to guide future planning efforts:

1. Avoid losses of wetlands and riverine habitat. Conserve, protect, and restore riverine habitats and fish communities (including flowing waters with velocities, backwaters, and oxbow lakes representative of the natural river). Any instream structures should provide fish passage.

Concur. The Corps is working closely with the Service to develop a mitigation plan to compensate for impacts to wetlands and riverine habitats. Additionally, a fish passage is included in alternative C. The optional measures under the CTO provide an opportunity to provide FRM while avoiding and minimizing wetland and riverine impacts depending on the measures ultimately included.

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

Concur. The Corps is working closely with the Service to develop a mitigation plan to compensate for impacts to all affected habitats.

3. Mitigation should be developed on a river basin basis to facilitate conservation of fish and wildlife resources. Measures should include compensation for function and habitat loss of the system.

Concur. The Corps is working closely with the Service to develop a mitigation plan to compensate for all affected habitat types. This mitigation would take place within the PR basin unless impossible due to lack of opportunity.

4. Downstream resources should be conserved, protected, and restored.

Concur. The Corps is working closely with the Service to develop a mitigation plan that would include all riverine impacts.

5. Detailed measures to offset fish and wildlife resource losses should be determined.

Concur. The Corps is working closely with the Service to develop a mitigation plan that includes measures to offset fish and wildlife resource losses.

6. A basin wide assessment of the hydrological changes, sedimentation, land use, and water quality should be conducted 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 through the basin.

Acknowledged. Identification and development of primarily ecosystem restoration projects are not authorized under the current authority; however, flood risk projects that have secondary ecosystem benefits may be considered (i.e. engineering with nature).

The following recommendations are provided particularly for Alternative C but should also be considered when developing the CTO. To make appropriate recommendations for the CTO alternative, the Service requests design details and potential impacts once finalized.

1. Further description and analysis of dam construction, operation, and maintenance should be provided.

Concur. The Corps will continue to coordinate closely with the Service throughout planning, preconstruction engineering and design (PED), and implementation.

2. Adequate turbidity, silt, and spoil containment barriers should be used to protect aquatic and wetland resources.

Concur. Coordination with the Service will continue to determine the best approach.

3. Incorporate sediment and erosion control measures during construction and revegetate
all disturbed areas immediately following construction. Incorporate measures to identify potential erosion issues, and control erosion and potential headcutting downstream.

Concur. A storm water pollution protection plan (SWPPP) will be prepared prior to and implemented during construction to address erosion control. Any temporarily disturbed areas would be revegetated to pre-construction condition. During PED, downstream impacts will be assessed and coordination with the resource agencies will take place to determine best approach if necessary.

4. Continue to include the Service in planning and project collaboration to evaluate and oversee environmental efforts.

Concur. The Corps will continue to coordinate closely with the Service throughout planning, PED, and implementation.

5. Mitigation should be implemented concurrent with construction.

Concur. A mitigation plan is being developed in close coordination with the Service and construction of any FRM features will not be implemented prior to implementation of mitigation.

6. Mitigation for unavoidable losses of fish and wildlife habitat, as reflected by loss of Average Annual Habitat Units (AAHUs), as well as loss of function, should be implemented within the Pearl River Basin. We recommend maintaining the interagency mitigation team for planning, coordination, future sampling and HEP analysis. At minimum 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. incorporate a public land measure for any impacts to public lands;
e. identification of the entity responsible for monitoring;
f. development of a contingency plan (i.e., adaptive management);
g. 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;
h. implement riverbank protection/stabilization in areas that are experiencing instability, gravel bar protection/restoration, sand and gravel mine restoration;
i. and establish a consultation process with appropriate Federal and State agencies to determine acceptable means of mitigation and success criteria.

Concur. The interagency mitigation team (IMT) will be maintained for planning, coordination, future sampling and HEP analysis. Additionally, all components above will be included in the mitigation plan to the extent possible.

7. Remove obsolete barriers, such as Poole's Bluff Sill, West Pearl lock and dam, and Bogue Chitto Sill to restore instream functions within the mainstem Pearl River as a form of partial mitigation for impacts to riverine functions within the project area.

Concur. The IMT will explore this option during mitigation planning and the engineering team will be included to confirm feasibility.

8. Assess existing constrictions on flow and improve for flood control considerations (i.e., in stream debris-clean up, bridge and culvert inadequacy for flow, railway obstruction, etc.).

Concur. The Corps has included bridge modifications and clearing and snagging tributaries as potential CTO measures. Addressing culvert inadequacy is a potential mitigation feature. These measures will be further analyzed during PED.

9. Include measures and features to promote aquatic organism passage throughout the project area, and ensure designs facilitate appropriate velocities for fish and turtles.

Concur. A fish passage is included in Alt C. During PED, design of the fish passage will be coordinated with the Service to ensure appropriate velocities for fish and turtles.

10. During low-flow periods, including droughts, sufficient flow should be maintained even if water levels fall below target pool elevations, matching the discharge from the Ross Barnett Reservoir.

Concur. A low flow gate is included in the design of Alt C.

11. 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. Develop plan to aid in sediment flushing.

Partially Concur. A low flow gate is included in the design of Alt C. This type of flushing analysis is not included in the existing proposed sediment study but could be completed in PED.

12. 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. Since benthic communities can be at risk of impairment (Cattaneo et al. 2020), such a plan should include ecological objectives and operations should limit or avoid adverse impacts downstream.

Partially Concur. This would need to be investigated for feasibility and would likely be done so in PED.

13. 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 for addressing that potential issue.

Concur. A Phase I Environmental Site Assessment (ESA) would be conducted prior to any form of construction. Based on the information provided by the NFI, there is a possibility that a Phase II ESA would have to be conducted. A phase II ESA could include sampling of both ground water and soils within the areas of concern.

14. Watershed, sediment, and water quality analysis within the Pearl River Basin is recommended, which may help identify and develop ecosystem restoration projects that could reduce flood risk throughout the basin. In addition, 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 (ER 1110-2-8154; engineer regulation on water quality).

Partially Concur. Sediment, and water quality analysis will be conducted within the project area and downstream to a distance yet to be confirmed. Additionally, a monitoring plan will be developed and implemented in coordination with the natural resource agencies that will include long-term water quality and quantity monitoring up and down stream and within the expanded channel. Identification and development of primarily ecosystem restoration projects are not authorized under the current authority; however, flood risk projects that have secondary ecosystem benefits may be considered (i.e. engineering with nature).

15. 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.

Concur. This could be accomplished through mitigation efforts. The Corps will continue to coordinate closely with the Service to develop a mitigation plan.

16. 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.

Concur. A Phase I ESA would be conducted prior to any form of construction. Based on the information provided by the NFI, there is a possibility that a Phase II ESA would have to be conducted. A phase II ESA could include sampling of both ground water and soils within the areas of concern.

17. 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 preauthorization for such mitigation if it is determined necessary.

Partially Concur. This is not included in the existing proposed sediment study, only a screening for impacts. However, it could be included and conducted in PED.

18. 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.

Concur. As part of ESA consultation, this plan will be developed in coordination with the service.

19. Creation and reforestation of a riparian zone along the toe of the levee 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.

Concur. This could be considered during mitigation planning and optimized in PED.

20. 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.

Concur. Any unavoidable impact to public lands would be mitigated on public lands.

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

Concur. All mitigation lands are purchased in fee and deeds include restrictions to ensure protection of the site in perpetuity.

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

Concur. The Corps will continue to coordinate with the Service and other resource agencies throughout the planning and implementation phases.

23. Loss of any flows and the resulting potential changes to water quality, including salinities, within the Mississippi Sound should be monitored. Details regarding water quality parameters and location should be developed with the LDWF Marine

Fisheries staff.

Acknowledged. The Corps does not expect any appreciable changes to existing conditions below Copiah Creek, and therefore an assessment of the Mississippi Sound would not be necessary.

24. Undeveloped portions of the floodplain serve to absorb and store storm run-off and reduce additional flood damages. 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. Floodplain ordinances could be an effective measure to avoid additional future flood damages throughout the Jackson metropolitan area.

Concur. It is against The Corps policy to induce development within a floodplain. That being said, it is anticipated that if Alt C is implemented, the floodplain would be redefined.

25. Federal and state listed, and at-risk mussel and turtle species relocations should be conducted prior to dredging and construction activities.

Concur. As part of ESA consultation, this effort will be developed in coordination with the Service and implemented prior to construction.

26. The Service recommends continued consultation on federally protected species.

Concur. The Corps will continue to coordinate closely with the Service to ensure compliance with the ESA.