United States Department of the Interior

FISH AND WILDLIFE SERVICE
Louisiana Ecological Services
200 Dulles Drive
Lafayette, Louisiana 70506

October 24, 2019

Mr. Walt Dinkelacker
President, Headwaters Inc.
PO Box 2836
Ridgeland, MS 39158

Dear Mr. Dinkelacker:

This document transmits the Fish and Wildlife Service's (Service) biological opinion (enclosed), regarding the Rankin Hinds Pearl River Flood and Drainage Control District's (District) Pearl River Basin, Mississippi, Federal Flood Risk Management Project, Hinds and Rankin Counties, Mississippi (commonly referred to as the One Lake Project). The U.S. Army Corps of Engineers' (USACE) is authorized by Congressional actions to construct a flood risk reduction project; the District has undertaken the plan formulation and environmental compliance for that project's study.

The enclosed biological opinion addresses the proposed flood risk management projects effects on the ringed map (sawback) turtle (*Graptemys oculifera*), Gulf sturgeon (*Acipenser oxyrhynchus desotoi*), wood stork (*Mycteria americana*), the Northern long-eared bat (*Myotis septentrionalis*) and the inflated heelsplitter (*Potamilus inflatus*) in accordance with section 7 of the Endangered Species Act (Act) of 1973, as amended (16 United States Code [U.S.C.] 1531 *et seq*.).

The enclosed biological opinion, is based on information provided in the District's June 17, 2019, biological assessment (BA) and the August 23, 2019, revised BA. Additional information was also provided informally during the consultation process. A complete administrative record of this consultation (Service Log No. 04EL1000-2020-F-0109) is on file at the Service's Louisiana Ecological Services Office.

The Service appreciates the District's continued cooperation in the conservation of the threatened and endangered species, and their critical habitats. If you have any questions regarding the enclosed biological opinion, please contact Mr. David Walther (337-291-3122) of this office.

Sincerely,

Joseph A. Ranson
Field Supervisor
Louisiana Ecological Services Office

Biological Opinion

Pearl River Watershed, Hinds and Rankin Counties, Mississippi Flood Reduction Project

FWS Log #: 04EL1000-2020-F-0109

Prepared by:

U.S. Fish and Wildlife Service
Louisiana Ecological Services Field Office
200 Dulles Drive
Lafayette, LA 70506

October 23, 2019

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EXECUTIVE SUMMARY

This Endangered Species Act (ESA) Biological Opinion (BO) of the U.S. Fish and Wildlife Service (Service) addresses the potential effects of the Pearl River Basin, Mississippi, Federal Flood Risk Management Project, Hinds and Rankin Counties, Mississippi being proposed by the Rankin Hinds Pearl River Flood and Drainage Control District (FDCD). The U.S. Army Corps of Engineers Vicksburg District (USACE) by a January 31, 2018, letter has agreed that the FDCD will be the designated non-federal representative for the consultation. That project is proposed to provide economic and flood control benefits to the Jackson, Mississippi, area by the deepening and widening the floodplain and the installation of a new downstream weir. The FDCD determined that the Action is likely to adversely affect the ringed map (sawback) turtle (*Graptemys oculifera*), Gulf sturgeon (*Acipenser oxyrhynchus desotoi*) and its critical habitat and requested formal consultation with the Service. The BO concludes that the Action is not likely to jeopardize the continued existence of these species and is not likely to destroy or adversely modify designated critical habitat. This conclusion fulfills the requirements applicable to the Action for completing consultation under §7(a)(2) of the Endangered Species Act (ESA) of 1973, as amended, with respect to these species and designated critical habitats.

The FDCD also determined and requested Service concurrence that the Action is not likely to adversely affect the wood stork (*Mycteria americana*), the Northern long-eared bat (*Myotis septentrionalis*) and the inflated heelsplitter (*Potamilus inflatus*); these species have no designated critical habitat within the project area. We provide our basis for this concurrence in section 3 of the BO. This concurrence fulfills the requirements applicable to the Action for completing consultation with respect to these species and designated critical habitats.

In addition, the BA addressed the previously listed bald eagle (*Haliaeetus leucocephalus*) and Louisiana black bear (*Ursus americanus luteolus*) and the extirpated (from the Pearl River drainage basin) pearl darter (*Percina aurora*). Because the eagle and the bear are no longer listed the ESA does not apply to them and the darter is not found in the project area thus it will not be impacted by the project therefore we will not address them in this BO.

The FDCD has developed a Channel Improvement Plan, also referred to as Alternative C, or the One Lake project, that consists of excavation of approximately 25 million cubic yards from the floodplain, extending from River Mile (RM) 284.0 to RM 293.5 (approximately 9.5 miles), and ranging in width from 400 to 2,000 feet. Some existing levees will be set back and new levees constructed with large amounts of fill areas placed behind them. The elevated land mass behind the levees will range from 200 to over 1,000 feet in width. To maintain water supply at the J. H. Fewell Water Treatment Plant (WTP) located at RM 290.7, an approximately 1,500-foot-long weir will be constructed at RM 284, creating a 1,500-acre pool area at the downstream limits of the project area and providing flood risk management benefits, recreation, and long-term maintenance reduction. The approximately 200-foot-wide existing weir at the J.H. Fewell WTP will be removed. Islands will be created from RM 289.5 to RM 292.0, some of which will be used to maintain and create habitat areas for local species.

It is the Service's opinion that the project would not jeopardize the ringed map turtle or the Gulf sturgeon nor destroy or adversely modify designated critical habitat for the Gulf sturgeon to the degree that it would result in jeopardy. The Service also concurred that the proposed Action is not likely to adversely affect the Northern long-eared bat, the wood stork, inflated heelsplitter and the pearl darter.

The BO includes an Incidental Take Statement that requires the USACE to implement reasonable and prudent measures that the Service considers necessary or appropriate to minimize the impacts of anticipated taking on the listed species. Incidental taking of listed species that is in compliance with the terms and conditions of this statement is exempted from the prohibitions against taking under the ESA.

The Action considered in this BO includes a conservation measure to relocate turtles from Crystal Lake within the construction area to the Lakeland population area and the relocation and protection of nests prior to construction would also be done. Creation and protection of nesting, basking and feeding habitat as well as the protection of approximately 10 miles of river bank and adjoining nesting and basking habitat are also included. In addition, the monitoring of the relocated turtles, nests and the population in the Action Area through the sampling, including but not limited to the capturing, tagging, tracking, observing and taking measurements, of individuals would be undertaken. Through the Incidental Take Statement, the Service authorizes these conservation measures as an exception to the prohibitions against trapping, capturing, or collecting listed species. These conservation measures are identified as a Reasonable and Prudent Measure below, and we provide Terms and Conditions for its implementation. Sampling protocols for the ringed map turtle should significantly reduce the likelihood of any lethal or injurious incidental take from occurring.

In the Conservation Recommendations section, the BO outlines voluntary Actions that are relevant to the conservation of the listed species addressed in this BO and are consistent with the authorities of the USACE.

Reinitiating consultation is required if the USACE retains discretionary involvement or control over the Action (or is authorized by law) when:

(a) the amount or extent of incidental take is exceeded;
(b) new information reveals that the Action may affect listed species or designated critical habitat in a manner or to an extent not considered in this BO;
(c) the Action is modified in a manner that causes effects to listed species or designated critical habitat not considered in this BO; or
(d) a new species is listed or critical habitat designated that the Action may affect.

CONSULTATION HISTORY

This section lists key events and correspondence during the course of this consultation. A complete administrative record of this consultation is on file in the Service's Louisiana Ecological Services Office.

2013-04-29 - Rankin Hinds Pearl River Flood and Drainage Control District (FDCD) holds an interagency meeting to discuss the proposed feasibility and environmental impact study regarding flood damage reduction alternatives along the Pearl River in Hinds and Rankin Counties, Mississippi.

2014-04-22 – Meeting with representatives of the FDCD and Mississippi Department of Wildlife Fisheries and Parks (MDWFP) to discuss potential alternatives and potential issues related to the gulf sturgeon and ringed map turtle.

2017-08-29 – Meeting with representatives of the FDCD and the USACE to discuss the ESA section 7 consultation process for the proposed project.

2018-01-31 – The USACE attached and submits the FDCD prepared biological assessment and requests formal consultation on the proposed project and its effects on federally listed species. The USACE designates the Rankin Hinds Pearl River Flood and Drainage Control District (FDCD) as the designated non-Federal representative that we work directly with during formal consultation process.

2018-03-08 – The Service informs the FDCD that formal consultation cannot be initiated until a complete BA is submitted; the Service provides comments on the BA and requests additional information.

2019–06-17 – The FDCD provides the Service with a revised BA.

2019–07-18 – The Service provides comments on the June BA and requests additional information.

2019–07-18a – The FDCD informs the Service that the June BA initiated formal consultation.

2019–07-19 – The Service agrees that formal consultation was initiated on June 17, 2019.

2019-08 -23 – The FDCD provides the Service with a revised BA and appendices containing hydrologic data for the project, engineer drawings of the projects structures, and fish passage.

BIOLOGICAL OPINION

1. INTRODUCTION

A biological opinion (BO) is the document that states the opinion of the U.S. Fish and Wildlife Service (Service) under the Endangered Species Act of 1973, as amended (ESA), as to whether a Federal Action is likely to:

- jeopardize the continued existence of species listed as endangered or threatened; or
- result in the destruction or adverse modification of designated critical habitat.

Updates to the regulations governing interagency consultation (50 CFR part 402) become effective on October 28, 2019 [84 FR 44976]. We are applying the updated regulations to this ongoing consultation. As the preamble to the final rule adopting the regulations noted, "[t]his final rule does not lower or raise the bar on section 7 consultations, and it does not alter what is required or analyzed during a consultation. Instead, it improves clarity and consistency, streamlines consultations, and codifies existing practice." We have reviewed the information and analyses relied upon to complete this BO in light of the updated regulations and conclude the BO is fully consistent with the updated regulations.

The Federal Action addressed in this BO is the proposed Pearl River Watershed, Hinds and Rankin Counties, Mississippi Flood Reduction Project (the Action) being developed by the FDCD. This BO considers the effects of the Action on the Gulf sturgeon (*Acipenser oxyrhynchus desotoi*) and ringed map (sawback) turtle (*Graptemys oculifera*), and designated critical habitat for the Gulf sturgeon.

The USACE determined that the Action is not likely to adversely affect the Northern long-eared bat (*Myotis septentrionalis*), the wood stork (*Mycteria americana*), inflated heelsplitter (*Potamilus inflatus*) and the pearl darter (*Percina aurora*). The Service concurs with these determinations, for reasons we explain in section 2 of the BO.

A BO evaluates the consequences to listed species and designated critical habitat caused by a Federal action, activities that would not occur but for the Federal action, and non-Federal actions unrelated to the proposed Action that are reasonably certain to occur (cumulative effects), relative to the status of listed species and the status of designated critical habitat. A Service opinion that concludes a proposed Federal action is *not* likely to jeopardize species and is *not* likely to destroy or adversely modify critical habitat fulfills the Federal agency's responsibilities under §7(a)(2) of the ESA.

"*Jeopardize the continued existence*" means to engage in an Action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR §402.02). "*Destruction or adverse modification*" means a direct or indirect alteration that appreciably diminishes the value of designated critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features (50 CFR §402.02).

This BO uses hierarchical numeric section headings. Primary (level-1) sections are labeled sequentially with a single digit (e.g., 2. PROPOSED ACTION). Secondary (level-2) sections within each primary section are labeled with two digits (e.g., 2.1. Action Area), and so on for level-3 sections. The basis of our opinion for each listed species and each designated critical habitat identified in the first paragraph of this introduction is wholly contained in a separate level-1 section that addresses its status, environmental baseline, effects of the Action, cumulative effects, and conclusion

2. PROPOSED ACTION

Under the authority of Section 211 of the Water Resources Development Act of 1996, the USACE assigned the FDCD as the non-federal sponsor to conduct the feasibility studies, environmental impact studies, and to optionally design and construct this federally authorized flood risk management project. The FDCD is proposing the Pearl River Watershed Project in Hinds and Rankin Counties, Mississippi. The purpose of the project is to provide flood damage risk management along the Pearl River in Hinds and Rankin Counties, Mississippi. The project would provide the flood reduction benefits, as well as maintain the water supply for the City of Jackson's Fewell Water Treatment Plant, and provide potential recreational benefits. The plan is also referred to as Alternative C, the Channel Improvement Plan or One Lake.

The proposed Action (Figure 2.1) includes the construction of a weir at RM 284; excavation of approximately 25 million cubic yards from approximately RM 284.0 to RM 293.5; and widening of an approximately 9.5-mile-long reach of the Pearl River. The newly excavated channel would range in width from approximately 400 to 2,000 feet. Excavated material would be placed adjacent to and behind existing levees; some material would also be placed within the floodplain to create islands from RM 289.5 to RM 292. Islands would be created for native wildlife and sandbars, and other natural features would be created throughout the area for turtle habitat. The channel would be excavated to varying depths to facilitate aquatic species habitat. Over 4 miles of an existing levee section along the eastern floodplain would be relocated further east reconnecting some of the floodplain and an existing weir structure located at RM 291 would be removed. The existing weir is approximately 200 feet in length and provides water for the City of Jackson’s Fewell Water Treatment Plant. Downstream of the proposed weir (RM 284) an existing ring levee would be upgraded around the Savannah Waste Water Treatment Plant. The plant is located on the west bank of the river between RM 281 and RM 283. To the east of the proposed weir there would be a low flow diversion channel and a fish passage channel. North of the improved channel, a total of approximately 10 miles of river bank would also be protected; this Action is in accordance with the ringed map turtle recovery plan. The relocation of ringed map turtles from Crystal Lake and the relocation of nests from the excavation area is also planned. An adaptive management and monitoring plan will be developed in conjunction with the Service and the Mississippi Department of Wildlife, Fisheries and Parks (MDWFP) which would provide ongoing monitoring, long-term management, and habitat protection benefits for the listed turtle.

The Service analyzed impacts from the Action by dividing the project into impacts primarily associated with: 1) construction of the channel (e.g., excavation) and relocation of the levee and 2) impacts associated with the construction of the weir, its appurtenances and the impacts associated with the functions of the enlarged channel. Details of those features are described below in **Section 2.2 Channel Excavation and Levee Relocation** and **Section 2.3 Weir Construction and Impoundment**. Future detailed project planning may result in changes to project features and construction methods. Such changes may necessitate future consultations pending the extent and magnitude of the potential effects of those project modifications.

2.1. Action Area

For purposes of consultation under ESA §7, the Action Area is defined as "all areas to be affected directly or indirectly by the Federal Action and not merely the immediate area involved in the Action" (50 CFR §402.02). The BA describes the project area to include 2,450 acres along the main channel of the Pearl River from RM 301.77 to 284 in Hinds and Rankin Counties, Mississippi. The Service defines the "Action Area" for this consultation to include the portion of the Pearl River from the Ross Barnett spillway (RM 301.77) to 1.6 miles downstream of the proposed project weir at RM 284 (see following sections regarding the delineation of this area) (Figure 2.2). The Action Area also includes riparian areas adjacent to the river where construction activities will occur. The Action Area extends upstream of the proposed project to include all river miles that will be impacted by altered flow regimes, at approximately RM 301.77. The Action Area extends downstream (approximately 1.6 miles) of the proposed impoundment as this represents a sufficient downstream distance outside of the construction limits to determine if geomorphology and/or water quality impacts would occur as a result of the Action.

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

Immediately upstream of Jackson and on the Pearl River at River Mile (RM) 301.77 is the Ross Barnett Reservoir. The Pearl River Valley Water Supply District (PRVWSD) constructed the reservoir in the mid-1960s, and they retain authority for operation and maintenance of the project. The relatively shallow impoundment (mean depth of 12 feet) inundated approximately 24 miles of the Pearl River. In the northern part of Jackson, the City of Jackson built a low weir in 1915 at approximately RM 290.7 for water supply, which still provides a large portion of the city's water supply.

The 1960 Flood Control Act authorized construction of the Jackson (i.e., Fairgrounds) and East Jackson levees to address flooding in the area; the USACE completed that project in 1968 with an extension of the Jackson levee at Fortification Street completed in 1984. The existing flood control project consists of those two earthen levees on either side of the river totaling 13.2 miles. There is also channel work associated with the levees which includes 9.3 miles of enlargement and realignment of the main river channel through the town of Jackson (approximately 5 miles of cutoffs). Maintenance includes any necessary periodic removal of vegetation along a 650-foot-wide cleared strip of floodplain along the river and complete clearing downstream of that; a total of 346 acres of the floodplain (approximately 40 percent of the riparian area) is maintained in some form of cleared or partially cleared floodplain.

Two former landfills (Gallatin Street and Jefferson Street) and the former Gulf States Creosote plant are also located within the proposed project area. The 62-acre Gallatin Street landfill contains urban and industrial trash. Leachates from within the site contain cadmium, lead, and nickel above the regulatory standards. Debris from this landfill is reported to be washing into the river. The 45-acre Jefferson Street (or Lafleurs Landing) landfill also has debris that can be eroded during high river stages. The Environmental Protection Agency's (EPA) Final Preliminary Assessment/Site Inspection (PSA/SI) done in 2003 found barium, cobalt, manganese, and zinc, as well as creosote residuals consisting of a variety of polycyclic aromatic hydrocarbons (PAHs).

Downstream of the project area, the Pearl River flows through mostly rural areas. In this area between 76 and 90 percent of the land in counties adjacent to the river is forested (Oswalt 2013). There are many tributaries to the Pearl River south of the project area, but the two largest tributaries occur in the middle portion of the watershed. The Strong River (located at approximately RM 227) flows into the Pearl River just south of Georgetown, and Silver Creek (located at approximately RM 186) joins with the Pearl just south of Monticello. The Bogue Chitto River, located at approximately RM 37, is the largest tributary in the lower Pearl River watershed.

The lower portion of the Pearl River watershed has experienced more land conversion than the middle portion but less than around Jackson. Counties along the lower portion of the Pearl River have between 51 and 75 percent forested lands (Oswalt 2013). In the lower watershed, the Pearl River has been altered by the construction of two navigation channels, the Pearl River Navigation Channel and the West Pearl River Navigation Channel. The West Pearl River Navigation Channel includes three navigation locks in the channel and three sills (i.e., weirs approximately 12 feet in height). The sills are located on the Bogue Chitto River, the Pearl River at Pools Bluff, and near the southern navigation lock. The Pearl River Navigation Project resulted in the snagging and clearing of the river between Bogalusa, Louisiana, and Columbia, Mississippi. Downstream from approximately the latitude of Bogalusa, Louisiana, the Pearl River becomes a braided river system with numerous bifurcations.

Hydrology

The Ross Barnett Reservoir was constructed in 1961 and was filled by 1965. Operationally, the Ross Barnett Reservoir must maintain a minimum flow of 112 million gallons of water per day or approximately 170 cubic feet per second (cfs). This discharge rate is greater than low-flow discharge rates experienced preconstruction; 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 Ross Barnett Reservoir is eutrophic with low dissolved oxygen (DO) levels documented in the summer months (EPA 1975; Mississippi DEQ 2018; Phallen et al. 1988).

Prior to and after construction of the Ross Barnett Reservoir, Pearl River flows varied primarily in response to rainfall in the basin (Hasse 2006). Groundwater discharge into some of the tributary streams also contributes to flows (Lang 1972; Lee 1985). Bednar (1976) postulated that during low discharge periods aquifer recharge could further reduce flows in the project area based on information collected approximately 2.3 miles south of the proposed weir. Because that study did not examine geological formations, the potential extent of possible recharge zones within the project area is unknown. The bed and banks of the river are primarily comprised of silts, sands, sandstone, and clays, including marl, with gravel deposits also present (Monroe 1954). Some limestone outcroppings occur along the banks as well (Crider 1906). Weathering of the clays can reduce their cohesiveness allowing the Pearl River to meander naturally in the floodplain (Monroe 1954).

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

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

Conversely, the examination of data from three gauges from within and downstream of the project area (i.e., Jackson, Byram, and Rockport) was performed during the feasibility study by contractors for the FDCD to determine possible changes in discharge and stage (i.e., water level or gauge height) relationship to determine if the Pearl River had undergone any channel changes. Based on that examination it was concluded that the construction of the reservoir, land use changes, urbanization, and channel improvement could have resulted in some instability but has since re-stabilized and remained in a state of dynamic equilibrium. The Jackson gauge used in the analysis is located approximately 1.3 miles upstream of the proposed weir (i.e., within the project area), while the Byram and Rockport gauges are located approximately 14 and 40 miles downstream of the proposed weir, respectively. Because stage-discharge measurements are not taken continually the data represents periodic measurements over the years. Data from the Jackson gauge included the years from 1929-1972, 1973-1977, 1978-1989, and 1990-2010. The Byram gauge included data from only 1984 to 1993 while the Rockport gauge had data from 1940-1949, 1984-1991, and 1992-2010. Based on the examination of that data the stage-discharge relationship was determined to be stable for the Jackson and Byram gauges (Graphs 2.1 and 2.2). For the Rockport gauge (Graph 2.3) there was a slight lowering of the stages (generally less than a foot) for discharges between 32,000 and 51,000 cfs for the time period between the 1940’s and 1980’s and there was also a possible lowering of the stages for flows less than 4,000 cfs between the 1984-1991 and the 1992-2010 period. The Rockport gauge is located in the same reach of the river where Tipton et al. (2004) and Piller et al. (2004) reported some instability during the later time period.

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

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

Hydrologic modeling of the Action Area indicated that the range of velocities within the river varied with the cross-section of the river and floodplain and the river’s discharge (Graph 2.4).

Average cross-sectional velocities varied from approximately 0.27 feet per second (fps) to 2.2 fps.

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

2.2. Channel Excavation and Levee Relocation

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

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

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

Approximately 10 miles of river bank would also be protected. The prioritized areas where this land would be located is; 1) north of the improved channel, 2) north of the Ross Barnett Reservoir, and 3) south of the weir. This action is in accordance with the ringed map turtle recovery plan. The relocation of ringed map turtles from Crystal Lake and the relocation of nests from the excavation area is also planned. An adaptive management and monitoring plan will be developed in conjunction with the Service and the MDWFP which would provide ongoing monitoring, long-term management, and habitat protection benefits for the listed turtle.

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

Excavation of the 25 million cubic yards would destroy approximately 1,433.5 acres of forested or scrub-shrub wetlands, 31.41 acres of accretion (e.g., sandbar, sandbank), and 65.1 acres of emergent wetlands. A total of 1,901 acres would be excavated and 947 acres would have earthen fill placed on them. Of the 1,901 acres to be excavated, 230.80 acres currently exist as the Pearl River.

2.3. Weir Construction and Impoundment

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

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

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

Because the low flow structure is designed to meet the required discharge of the Ross Barnett Reservoir, there will not be a change in the discharge from the proposed project. Average monthly discharge, along with the standard deviation and minimum monthly discharge from 1966 to 2013, are presented in Table 2.1. Typically, June through October have the lowest discharge while December through April have the highest discharge. May and November have discharges that transition between the high and low periods. The percentages of months having discharges less than 1,000, 2,000, 5,000, 10,000, 20,000 and 40,000 cubic feet per second (cfs) are presented in Table 2.2. In general, discharges greater than 5,000 cfs do not occur between June and November. Discharges greater than 20,000 cfs occur infrequently between December and May; that is most discharge rates are less than 20,000 cfs during that time period.

The range of velocities and water surface elevations presented in the tables below represent various flows with the 1,000 cfs discharge typically being equaled or exceeded about 54 percent of the time, the 2,000 cfs flow would be equaled or exceeded 42 percent of the time, the 5,000 cfs flow being equaled or exceeded 26 percent of the time, and 10,000 cfs flow being equaled or exceeded 13 percent of the time. Most of the discharges have their typical reoccurrence interval presented within the profile column. The weir would elevate the water surface within the Action Area from 258.1 feet (NAVD 88) to an approximate elevation of 260.95 feet (NAVD 88) for a river discharge of 20,000 cfs just upstream of the weir. Additional changes in water surface elevation are presented in Tables 2.3 through 2.7. As shown in the tables, the weir would elevate the water surface near the weir with greater differences being experienced when the river would have normally been at low flow conditions and smaller differences during larger discharge events.

Velocity differences within the channel would also occur (velocities presented in the tables and graphs are an average over the channel's cross section) with velocities being reduced for the length of the project (Graph 2.1). This trend remains fairly constant throughout the improved channel portion (Tables 2.3 through 2.5 and Graph 2.4) with variations caused primarily by differences in the proposed cross-section of the channel. Upstream of the approximate upper limit of the pool area (between RM 293 and 294) the trend begins to diminish (Table 2.6 and Graph 2.4), but the influence of the weir is still detectable up to approximately RM 295.7.

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

Between RM 293.9 (upper end of the improved channel) and RM 295.9 the river and floodplain will not be altered, but the water surface elevation will be reduced several feet for discharges between 10,000 cfs and 50,000 cfs. In this same general area there will be an increase in velocities (i.e., 1.28 feet per second [fps] to 5.85 fps) for discharges greater than 40,000 cfs (shaded area in Graph 2.4). This decrease in water surface and increase in velocities could result in scouring and destabilization of the banks (i.e., head cutting); however, analysis of the sheer strength (resistance to erosion) values within this reach would be well below the critical thresholds that would cause channel instability. This reach would be monitored for any changes in channel stability once constructed.

The weir is designed to be overtopped by the discharges occurring at the one-year frequency or greater. Studies have investigated geomorphological impacts from similar weirs. Gangloff et al. (2011) found narrower channel widths in streams with intact weirs. Helms et al. (2011) found intense sedimentation and altered geomorphology in upstream areas and immediately downstream of the weir. Pearson et al. (2016) observed that floodplains upstream of dams received larger amounts of sediment (including sand) during over bank floods. Ciski (2014) found that weirs with tops below channel banks still captured fine sediments and sand, but trapping of fines was minor and no major discontinuities in river morphology or sediment characteristics occurred. Skalak et al. (2008) discovered coarsening of downstream sediments. Ciski and Rhoads (2010) observed that if the weir does trap sediment, then downstream erosion of channel banks and the channel bed will occur through the formation of an inflection point in the water surface profile; this inflection or "nick" point would migrate toward the structure diminishing the extent of the backwater (i.e., sedimentation) zone. Sluice gates within the structure helped pass sediments downstream. Fencl et al. (2017) also found that the substrate coarsened downstream, but that a maximum of 1.6 miles downstream, the substrate returned to reference site conditions. The downstream area altered by weirs (i.e., widening and substrate changes) ranged from 0.13 to 1.6 miles with an average of 0.75 miles. The changes in the river's width and depth depended on local factors including geology, channel confinement, slope, and height of dam compared to bank height. Sedimentation starvation below dams can reduce the effect of downstream low-head dams. Upstream areas experienced an increase in mean depths. The impacted upstream area can vary by the slope of the river and the height of the weir.

To assess the potential capture of sediments, the FDCD contracted with Tetra Tech to develop a model of the area to compare existing conditions against those with the project constructed. The Tetra Tech model was developed on behalf of the Mississippi Department of Environmental Quality (MDEQ). This model uses Environmental Fluid Dynamics Code (EFDC) and Water Quality Analysis Simulation Program (WASP) to create a dynamic one-dimensional model from Jackson, MS, to Bogalusa, LA, and simulates hydraulics and water quality from January 1, 2000, through December 31, 2017. In addition to using 18 years of data, the model accounts for many hydraulic variables, including discharge flows (Table 2.7) and total suspended solids (Table 2.7). Implementation of the project results in less than 0.3 percent change in either direction on either variable. Based on this analysis they determined that the project is not predicted to impact sediment load or downstream discharges (and thereby downstream velocities); thus, the project would not be expected to affect the amount of sediment that would or would not be picked up downstream of the project area. However, within the Engineering Appendix a preliminary sediment transport analysis was conducted. That analysis indicated a reduction of sediment transport, especially at lower flows approximately between RM 285 and 290. This would indicate a potential sediment sink within the lake portion; and the appendix did state the need for additional sediment analysis. Reduced sediment transport could result in increased downstream erosion. To address that issue, monitoring at the weir and downstream for 1.6 miles would be incorporated into the monitoring and adaptive management plan.

To assess water quality the same Tetra Tech model was used. Parameters examined included temperature, dissolved oxygen (DO), total phosphorus, total suspended solids, biological oxygen demand (BOD), total nitrogen and chlorophyll a. Slight differences were noted for many of the parameters (Table 2.7) but no significant adverse effects were revealed.

2.4. Non-Federal Activities caused by the Federal Action

A BO evaluates the effects of a proposed Federal action. "Effects of the action are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (50 CFR §402.02).

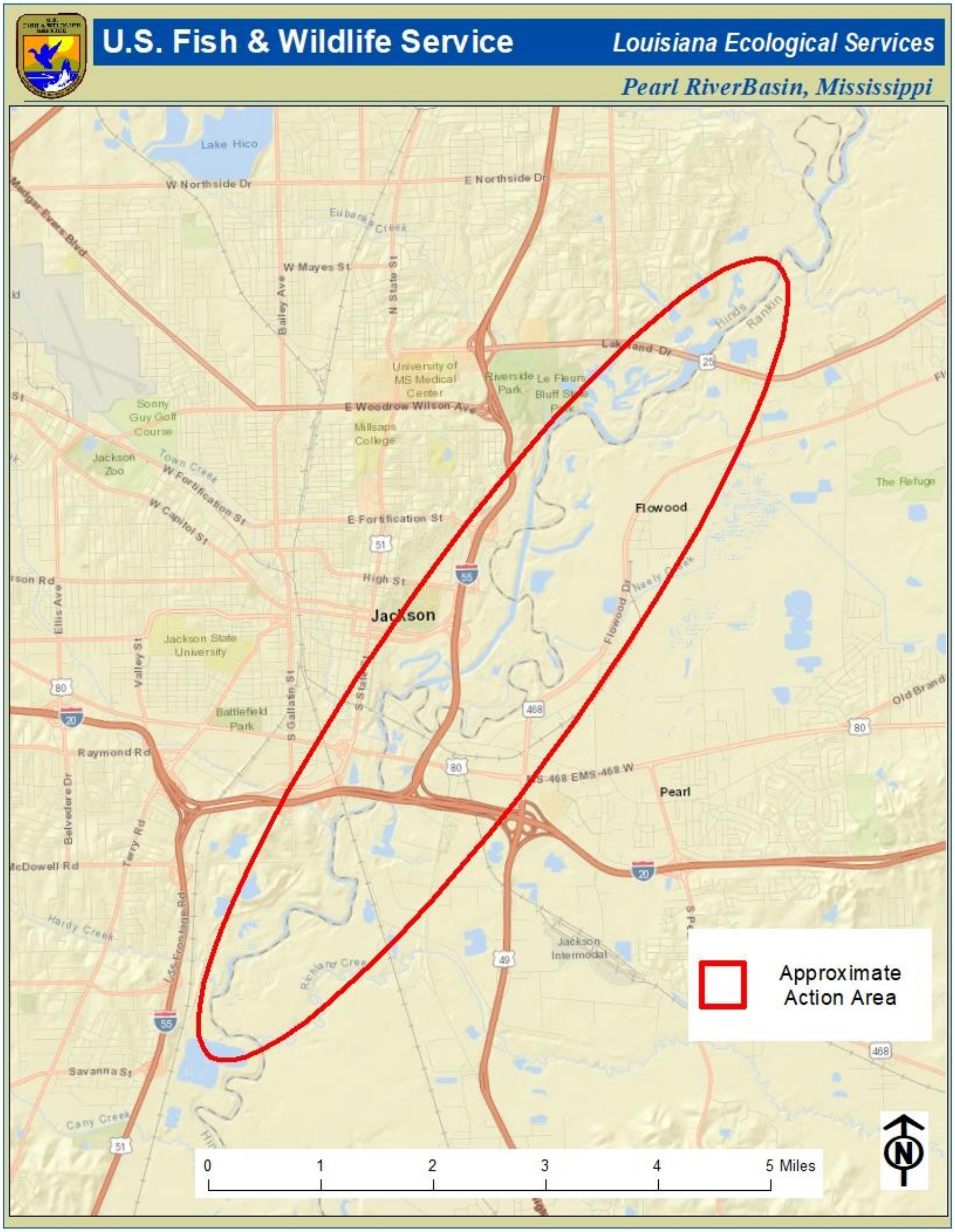
Alternative C includes the construction of additional natural areas and parks within significant portions of the project fill areas. Non-consumptive activities, such as hiking, outdoor photography, and wildlife viewing, would increase as these areas would be publicly available. These areas would complement Lefleur's Bluff State Park. Conversion of the forestland and other habitat types that currently exist and are inaccessible to water, will occur with the implementation of Alternative C. This alternative would increase water-dependent recreational opportunities, such as fishing, boating, and canoeing through additional public access such as boat ramps. Non-consumptive uses would increase because of the inclusion of multipurpose trails, wildlife viewing areas, amphitheaters, and campgrounds. The additional public access boat ramps and pedestrian access points associated with this alternative would increase recreation within the project area. Alternative C would improve access to the riverfront, increasing the opportunity for public recreational utilization.

Activities that would not occur but for the proposed Federal action include relocation or retrofitting of existing infrastructure within the action area (i.e. roads, bridges, pipelines, powerlines), riverfront access and development. These activities are expected to increase recreational opportunities, which will stimulate community development, population, and housing. Increased recreational use of the river from the upper end of the pool to reservoir could occur similar to consequences north of the Ross Barnett Reservoir; currently recreational activities do occur but are not as great (Selman and Jones 2017). Alternative C also has the inclusion of a fish passage channel next to the weir structure so that the weir would be less of an impediment to Gulf sturgeon.

2.5. Tables and Figures for Proposed Action

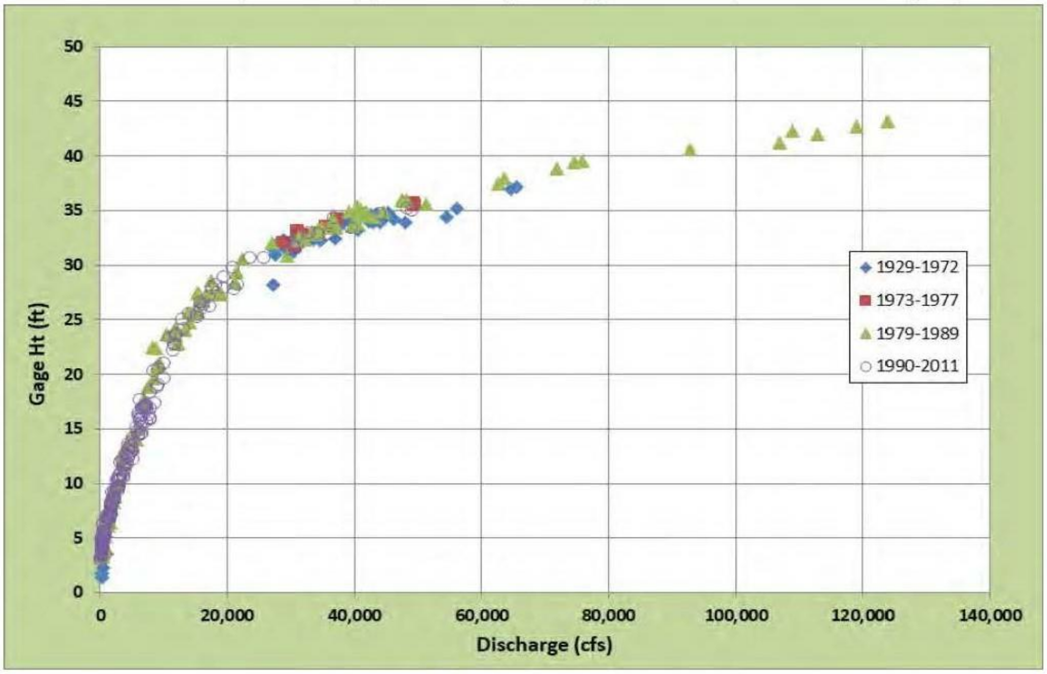
Figure 2.1 Proposed Channel Improvement Plan

Figure 2.2 Action Area



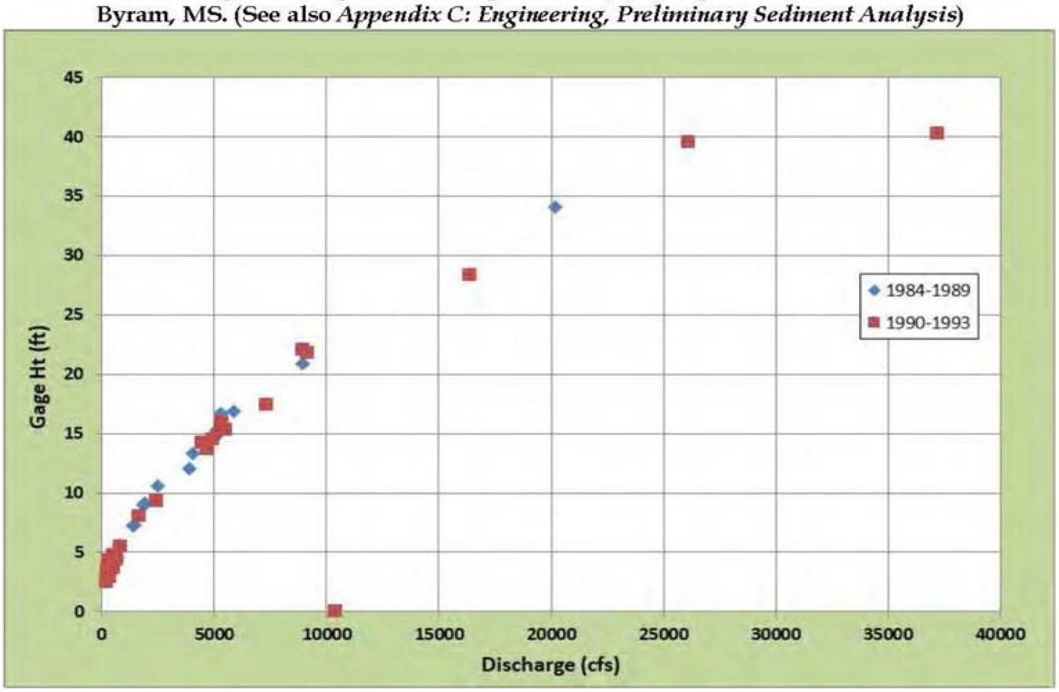
Graph 2.1

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



Graph 2.2

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



Graph 2.3

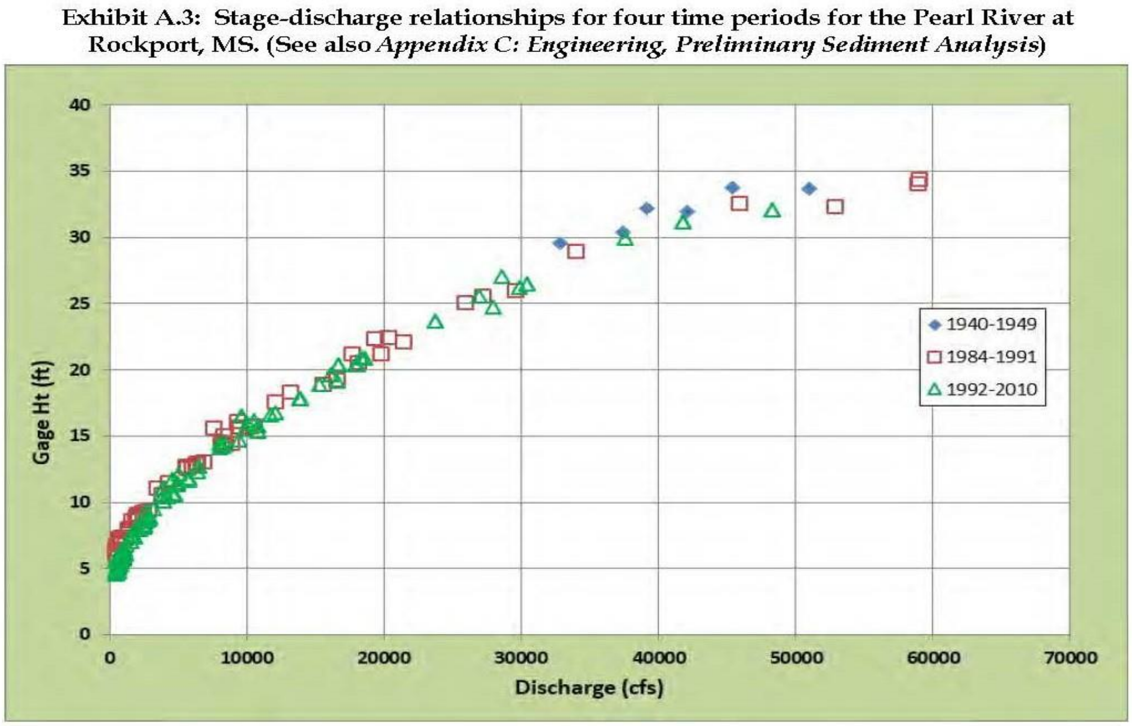


Table 2.1. Monthly average discharge (cfs), 1 Standard Deviation (STD) and minimum monthly average flow 1966-2013.

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

Table 2.2. Percent of months having discharge less than the rate indicated from 1966-2013.

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

Table 2.3. Hydrologic information for just above the proposed weir							
River Mile	Profile	Plan	Discharge	Water Surface Elevation	Velocity Total	Area	Top Width
			(cfs)	(ft)	(ft/s)	(sq ft)	(ft)
284.833	-	Existing	1000.00	238.43	1.17	851.32	137.08
284.833	-	Alt C	1000.00	258.40	0.05	22369.18	3182.28
284.833	-	Existing	10000.00	252.55	2.08	7497.75	1660.40
284.833	-	Alt C	10000.00	259.86	0.45	27544.17	3932.60
284.833	-	Existing	20000.00	258.10	2.09	19673.79	3698.12
284.833	-	Alt C	20000.00	260.95	0.83	32053.53	4378.40
284.833	2 YR	Existing	40000.00	264.05	1.67	55605.10	9560.92
284.833	2 YR	Alt C	40000.00	264.27	1.21	53155.65	8360.21
284.833	5 YR	Existing	50000.00	266.13	1.40	76860.01	10733.41
284.833	5 YR	Alt C	50000.00	266.32	1.18	71379.16	9239.55
284.833	10 YR	Existing	56800.00	267.20	1.35	88425.55	10858.47
284.833	10 YR	Alt C	56800.00	267.39	1.21	81291.73	9339.00
284.833	25 YR	Existing	73000.00	269.36	1.32	112014.10	10992.36
284.833	25 YR	Alt C	73000.00	269.55	1.27	101675.40	9469.48
284.833	50 YR	Existing	90000.00	271.42	1.23	134758.50	11070.64
284.833	50 YR	Alt C	90000.00	271.60	1.25	121130.50	9517.18
284.833	100 YR	Existing	106000.00	272.86	1.23	150825.60	11154.90
284.833	100 YR	Alt C	106000.00	273.06	1.28	135026.70	9594.28

Table 2.4. Hydrologic information for the area between I-20 and US 80							
River Mile	Profile	Plan	Discharge	Water Surface Elevation	Velocity Total	Area	Top Width
			(cfs)	(ft)	(ft/s)	(sq ft)	(ft)
287.14	-	Existing	1000.00	240.61	1.17	853.71	261.04
287.14	-	Alt C	1000.00	258.40	0.05	19424.23	1538.63
287.14	-	Existing	10000.00	254.29	1.14	8748.41	924.12
287.14	-	Alt C	10000.00	259.89	0.46	21717.10	1549.71
287.14	-	Existing	20000.00	259.79	1.40	17500.82	2262.55
287.14	-	Alt C	20000.00	261.03	0.85	23490.22	1557.56
287.14	2 YR	Existing	40000.00	265.84	1.45	31340.73	2310.40
287.14	2 YR	Alt C	40000.00	264.44	1.39	28841.54	1580.90
287.14	5 YR	Existing	50000.00	267.95	1.53	36962.38	2923.83
287.14	5 YR	Alt C	50000.00	266.51	1.56	32175.60	1786.84
287.14	10 YR	Existing	56800.00	269.10	1.61	40784.96	3839.39
287.14	10 YR	Alt C	56800.00	267.60	1.68	34312.81	2080.83
287.14	25 YR	Existing	73000.00	271.49	1.77	50877.87	4396.79
287.14	25 YR	Alt C	73000.00	269.82	1.95	40371.36	3382.07
287.14	50 YR	Existing	90000.00	273.71	1.93	60780.36	4521.68
287.14	50 YR	Alt C	90000.00	272.07	2.18	48410.02	3690.79
287.14	100 YR	Existing	106000.00	275.31	2.05	68093.63	4626.52
287.14	100 YR	Alt C	106000.00	273.53	2.43	53838.36	3779.51

Table 2.5. Hydrologic Information for the area between E. Fortification St. and the Water Works Weir							
River Mile	Profile	Plan	Discharge	Water Surface Elevation	Velocity Total	Area	Top Width
			(cfs)	(ft)	(ft/s)	(sq ft)	(ft)
290.45	-	Existing	1000.00	245.90	0.95	1048.46	317.47
290.45	-	Alt C	1000.00	258.40	0.05	21878.94	2269.97
290.45	-	Existing	10000.00	257.62	1.76	5689.12	594.83
290.45	-	Alt C	10000.00	259.95	0.39	25419.89	2321.46
290.45	-	Existing	20000.00	262.75	1.76	13908.46	3172.01
290.45	-	Alt C	20000.00	261.22	0.70	28421.88	2518.79
290.45	2 YR	Existing	40000.00	268.86	1.14	35196.52	3674.10
290.45	2 YR	Alt C	40000.00	264.87	1.02	39105.57	3170.99
290.45	5 YR	Existing	50000.00	271.14	1.14	44007.17	3926.98
290.45	5 YR	Alt C	50000.00	267.03	1.08	46106.50	3254.74
290.45	10 YR	Existing	56800.00	272.47	1.15	49241.71	3945.49
290.45	10 YR	Alt C	56800.00	268.18	1.14	49867.96	3261.55
290.45	25 YR	Existing	73000.00	275.28	1.21	60388.65	3982.73
290.45	25 YR	Alt C	73000.00	270.57	1.27	57677.16	3275.64
290.45	50 YR	Existing	90000.00	277.87	1.27	70733.42	4017.11
290.45	50 YR	Alt C	90000.00	273.00	1.37	65663.00	3289.99
290.45	100 YR	Existing	106000.00	279.81	1.35	78652.36	4126.38
290.45	100 YR	Alt C	106000.00	274.64	1.49	71065.68	3299.67

Table 2.6. Hydrologic Information for the area just downstream of the dam							
River Mile	Profile	Plan	Discharge	Water Surface Elevation	Velocity Total	Area	Top Width
			(cfs)	(ft)	(ft/s)	(sq ft)	(ft)
302.08	-	Alt C	1000.00	260.43	0.22	4546.82	458.15
302.08	-	Existing	10000.00	271.43	0.97	29436.15	5112.16
302.08	-	Alt C	10000.00	271.41	0.97	29332.66	5102.81
302.08	-	Existing	20000.00	275.02	1.56	53490.64	9232.33
302.08	-	Alt C	20000.00	274.91	1.57	52479.26	8773.74
302.08	2 YR	Existing	40000.00	279.69	0.70	113204.30	14348.72
302.08	2 YR	Alt C	40000.00	278.87	0.86	101558.70	13996.55
302.08	5 YR	Existing	50000.00	281.29	0.63	136908.00	15164.46
302.08	5 YR	Alt C	50000.00	280.72	0.71	128334.60	14970.76
302.08	10 YR	Existing	56800.00	282.08	0.62	149088.10	15300.98
302.08	10 YR	Alt C	56800.00	281.73	0.66	143659.50	15255.45
302.08	25 YR	Existing	73000.00	283.85	0.62	176337.50	15655.02
302.08	25 YR	Alt C	73000.00	283.22	0.67	166599.30	15505.50
302.08	50 YR	Existing	90000.00	285.61	0.61	204424.70	16313.44
302.08	50 YR	Alt C	90000.00	284.56	0.69	187586.40	15840.08
302.08	100 YR	Existing	106000.00	287.28	0.61	232381.90	17105.22
302.08	100 YR	Alt C	106000.00	285.68	0.72	205577.00	16334.50

Graph 2.3. Velocities in the Action Area. Green shade represents area north of the pool.

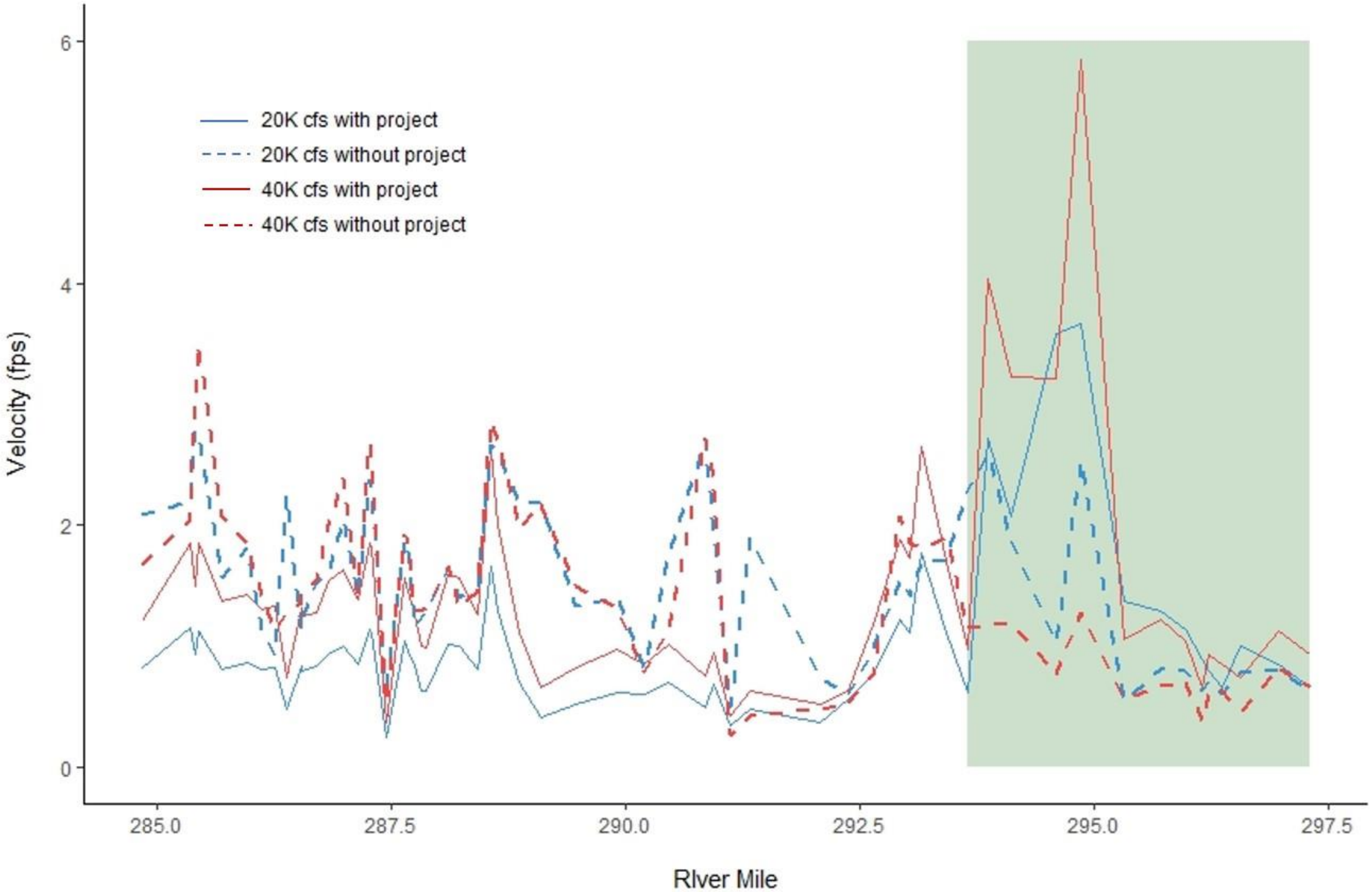


Table 2.7. Modeled Water Quality Parameters pre and post project.

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

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

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

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

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

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

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

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

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

3. CONCURRENCE

The USACE determined that the Action is not likely to adversely affect the wood stork and the Northern long-eared bat. The Service concurs with these determinations, for reasons we explain in this section.

3.1 Wood Stork

The threatened wood stork 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 primaries and secondaries and a short black tail. The head and neck are largely unfeathered and dark gray in color. Wood storks occur seasonally in Mississippi during the non-breeding season (May–October). Typical foraging sites include freshwater marshes, swales, ponds, hardwood and cypress swamps, narrow tidal creeks or shallow tidal pools, and artificial wetlands (such as stock ponds; shallow, seasonally flooded roadside or agricultural ditches; and impoundments).

Suitable habitat for this species is found within the project area and will be impacted; however, due to the amount of available habitat present in the state of Mississippi, we expect discountable and insignificant effects to the wood stork due to loss of available wetland habitat as a result of project implementation and the very low occurrence of wood storks in the area. In addition, these non-breeding adults are expected to avoid the project area during construction; therefore, the Service concurs with the USACE's determination that the proposed project may affect, but is not likely to adversely affect the wood stork.

3.2 Northern Long-eared Bat

The Northern long-eared bat (NLEB) is a small bat (3.0 to 3.7 inches in length, 9.0 to 10.0 inch wingspan) that is distinguished by its long ears compared to other *Myotis* bats. The bats are found in all or portions of 37 U.S. states, including northeastern Mississippi. A migrating species, the NLEB utilizes forested habitats in the summertime for roosting and rearing their young and hibernate in caves during winter. There is one known hibernaculum cave in Tishomingo County, Mississippi and no known maternity roost trees within the state.

White-nose syndrome, a deadly fungal infection that infects bats within hibernaculum, is the main threat to the NLEB. The fungus has spread to 28 of the 37 states within the bats range and includes locations within Mississippi. Under the NLEB final 4(d) rule, published February 16, 2016 (81 FR 1900 1922), the White-Nose Syndrome Buffer Zone was established to include all areas within 150 miles of the boundaries of U.S. counties or Canadian districts where the fungus has previously been detected. The project area falls within this buffer area but outside of the 0.25-mile (0.4 km) protected buffer zone of the known hibernaculum.

Secondary threats to the NLEB include the disturbance of roosts and hibernation areas, forest management practices, and forest habitat modifications (development, wind power development). The final 4(d) rule states availability of forested habitat does not now, nor will it likely in the future, limit the conservation of the species. The proposed project will not occur near or affect any known maternity roost trees, but will remove potential roosting and foraging habitat and could result in potential adverse effects. Under the final 4(d) rule, any incidental take resulting from forest conversion as a part of the channel excavation and levee realignment action of this project would be considered incidental take resulting from otherwise lawful activities and is not prohibited under the Endangered Species Act. Accordingly, the Service concurs with the USACE's determination that the Action may affect, but is not likely to adversely affect the NLEB.

This concurrence concludes consultation for the listed species and designated critical habitats named in this section, and these are not further addressed in this BO. The circumstances described in the Reinitiation Notice of this BO that require reinitiating consultation for the Action, except for exceeding the amount or extent of incidental take, also apply to these species and critical habitats.

4. GULF STURGEON

4.1. Status of Gulf Sturgeon

This section summarizes best available data about the biology and current condition of the Gulf sturgeon throughout its range that are relevant to formulating an opinion about the Action. The Service published its decision to list Gulf sturgeon as threatened on September 30, 1991 (56 FR 49653 49658). The Gulf Sturgeon Recovery/Management Plan was finalized September 22, 1995. The Service published its final decision designating critical habitat for Gulf sturgeon on March 19, 2003 (68 FR 13370 13495). The most recent 5-year status review of the species was completed September 22, 2009.

4.1.1. Description of Gulf Sturgeon

The Gulf sturgeon, also known as the Gulf of Mexico sturgeon, is an anadromous fish (breeding in freshwater after migrating up rivers from marine and estuarine environments), inhabiting coastal rivers from Louisiana to Florida during the warmer months and overwintering in estuaries, bays, and the Gulf of Mexico. It is a nearly cylindrical primitive fish embedded with bony plates or scutes. The head ends in a hard, extended snout; the mouth is inferior and protrusible and is preceded by four conspicuous barbels. The caudal fin (tail) is heterocercal (upper lobe is longer than the lower lobe). Adults range from 1.2 to 2.4 meters (m) (4 to 8 feet (ft)) in length, with adult females larger than males. The Gulf sturgeon is distinguished from the geographically disjunct Atlantic coast subspecies *(A. o. oxyrinchus)* by its longer head, pectoral fins, and spleen (Vladykov 1955; Wooley 1985). King et al. (2001) have documented substantial divergence between *A. o. oxyrinchus* and *A. o. desotoi* using microsatellite DNA testing.

4.1.2. Life History of Gulf Sturgeon

Like most sturgeons, the Gulf sturgeon is characterized by large size, longevity, delayed maturation, high fecundity, and far-ranging movements. Gulf sturgeon typically live for 20 to 25 years, but can reach ages of at least 42 years old (Huff 1975). Age at sexual maturity ranges from

8 to 12 years for females and 7 to 9 years for males (Huff 1975). High fecundity has been demonstrated by Chapman et al. (1993), who estimated that mature female Gulf sturgeon weighing between 29 and 51 kilograms (kg) (64 and 112 pounds (lb)) produce an average of 400,000 eggs. Long-range migrations from the open Gulf of Mexico to bays and estuaries to coastal rivers are also common. Migratory behavior of the Gulf sturgeon is likely influenced by sex and reproductive status (Fox et al. 2000), change in water temperature (Wooley and Crateau 1985; Chapman and Carr 1995; Foster and Clugston 1997), and increased river flow (Chapman and Carr 1995; Heise et al. 1999a, b; Sulak and Clugston 1999; Ross et al. 2000 and 2001b; Parauka et al. 2001).

In general, all life stages of Gulf sturgeon migrate into rivers in the spring (from late February to May), where sexually mature sturgeon spawn when the river temperatures rises to between 17 to 25 degrees Celsius (ºC) (75 degrees Fahrenheit (°F)). Similar to Atlantic sturgeon, Gulf sturgeon are believed to exhibit a long inter-spawning period, with male Gulf sturgeon capable of annual spawning, but females requiring more than one year between spawning events (Huff 1975; Fox et al. 2000) and only a small percentage of females spawn in a given year (Sulak and Clugston 1999; Pine et al. 2001). Therefore, Gulf sturgeon population viability is highly sensitive to changes in adult female mortality and abundance (Pine et al. 2001; Flowers 2008).

Spawning occurs in the upper reaches of rivers, at least 100 km (62 miles) upstream of the river mouth (Sulak et al. 2004), in habitats consisting of one or more of the following: limestone bluffs and outcroppings, cobble, limestone bedrock covered with gravel and small cobble, gravel, and sand (Marchant and Shutters 1996; Sulak and Clugston 1999; Heise et al. 1999a; Fox et al. 2000; Craft et al. 2001; USFWS unpub. data 2005; Pine et al. 2006). These hard bottom substrates are required for egg adherence and shelter for developing larvae (Sulak and Clugston 1998). Documented spawning depths range from 1.4 to 7.9 m (4.6 to 26 ft) (Fox et al. 2000; Ross et al. 2000; Craft et al. 2001; USFWS unpub. data 2005; Pine et al. 2006).

Gulf sturgeon eggs are demersal (bottom dwelling) and adhesive, and require at least 2 to 4 days to hatch (Parauka et al. 1991; Chapman et al. 1993). After hatching, larval Gulf sturgeon are particularly sensitive to water temperatures above 25°C (77°F) (Chapman and Carr 1995). Young-of-year (YOY) fish disperse widely throughout the river and remain in freshwater for 10 to 12 months after spawning occurs (Sulak and Clugston 1999). They are typically found in open sand-bottom habitat away from the shoreline and vegetated habitat.

Throughout early spring to late autumn, Gulf sturgeon of all ages remain in freshwater until fall (6 to 9 months) (Odenkirk 1989; Foster 1993; Clugston et al. 1995; Fox et al. 2000; Sulak et al. 2009). They typically occupy discrete areas either near the spawning grounds (Wooley and Crateau 1985; Ross et al. 2001b) or downstream areas referred to as summer resting or holding areas. These resting areas are often located in deep holes, and sometimes shallow areas, along straight-aways ranging from 2 to 19 m (6.6 to 62.3 ft) deep (Wooley and Crateau 1985; Morrow et al. 1998; Ross et al. 2001a, b; Craft et al. 2001; Hightower et al. 2002), and frequently near (not in) natural springs (Clugston et al. 1995; Foster and Clugston 1997; Hightower et al. 2002). The substrates consisted of mixtures of limestone and sand (Clugston et al. 1995), sand and gravel (Wooley and Crateau 1985; Morrow et al. 1998), or just sandy substrate (Hightower et al. 2002). With the exception of YOY fish, Gulf sturgeon do not typically feed during freshwater residency (Mason and Clugston 1993; Gu et al. 2001). Sulak et al. (2012) reported that the vast majority (approximately 94 percent) of juvenile, subadult, and adult Gulf sturgeon sampled from the Suwannee River exhibited complete feeding cessation for the 8 to 9-month summer residency; however, a small percentage (approximately 6 percent) of juveniles and subadults did feed in freshwater.

All non-YOY begin to migrate downstream from fresh to saltwater around September (at about 23°C [73 degrees Fahrenheit (°F)]) through November (Huff 1975; Wooley and Crateau 1985; Foster and Clugston 1997), and they spend the cool months in estuarine areas, bays, or in the Gulf of Mexico (Odenkirk 1989; Foster 1993; Clugston et al. 1995; Fox et al. 2002). During the fall migration, Gulf sturgeon may require a period of physiological acclimation to changing salinity levels, referred to as osmoregulation or staging (Wooley and Crateau 1985). This period may be short (Fox et al. 2002) as sturgeon develop an active mechanism for osmoregulation and ionic balance by age 1 (Altinok et al. 1998). Some adult Gulf sturgeon may also spawn in the fall (Randall and Sulak 2012).

Throughout fall and winter, juveniles feed in the lower salinity areas in the river mouth and estuary (Sulak and Clugston 1999; Sulak et al. 2009), while subadults and adults migrate and feed in the estuaries and nearshore Gulf of Mexico habitat (Foster 1993; Foster and Clugston 1997; Edwards et al. 2003, 2007; Parkyn et al. 2007). Some Gulf sturgeon may also forage in the open Gulf of Mexico (Edwards et al. 2003).

The Gulf sturgeon is a benthic (bottom dwelling) suction feeder: it feeds mostly upon small invertebrates in the substrate using its highly protrusible (capable of extension) tubular mouth. The type of invertebrates ingested varies by habitat but are mostly soft-bodied animals that occur in sandy substrates. YOY Gulf sturgeon feed on freshwater aquatic invertebrates, mostly insect larvae and detritus (Mason and Clugston 1993; Sulak and Clugston 1999; Sulak et al. 2009). Juveniles (less than 5 kg (11 lbs), ages 1 to 6 years) forage in lower salinity habitats near the river mouth and in the estuaries, and subadults and adults feed in the estuary and nearshore feeding grounds in the Gulf of Mexico (Foster 1993; Foster and Clugston 1997; Edwards et al. 2003, 2007; Parkyn et al. 2007). Prey in estuarine and marine habitats include amphipods, brachiopods, lancelets, polychaetes, gastropod mollusks, shrimp, isopods, bivalve mollusks, and crustaceans (Huff 1975; Mason and Clugston 1993; Carr et al. 1996; Fox et al. 2000; Fox et al. 2002). Ghost shrimp (*Lepidophthalmus louisianensis*) and haustoriid amphipods (e.g., *Lepidactylus spp.*) are strongly suspected to be important prey for adult Gulf sturgeon over 1 m (3.3 ft) in length (Heard et al. 2000; Fox et al. 2002).

Previous tagging studies indicated that Gulf sturgeon exhibit river fidelity (USFWS and GSMFC 1995). Stabile et al. (1996) identified five regional or river-specific stocks (from west to east): (1) Lake Pontchartrain and Pearl River, (2) Pascagoula River, (3) Escambia/Conecuh and Yellow Rivers, (4) Choctawhatchee River, and (5) Apalachicola, Ochlockonee, and Suwannee Rivers. Dugo et al (2004) reported that genetic structure occurs at the drainage level for the Pearl, Pascagoula, Escambia/Conecuh, Yellow, Choctawhatchee, and Apalachicola rivers (no samples were taken from the Suwannee population). Gulf sturgeon do make inter-river movements (USFWS unpubl. data 2012), and more genetic research is needed to determine if inter-stock movement is resulting in inter-stock reproduction.

4.1.3. Numbers, Reproduction, and Distribution of Gulf Sturgeon

Historically, the Gulf sturgeon occurred from the Mississippi River east to Tampa Bay. Its present range extends from Lake Pontchartrain and the Pearl River system in Louisiana and Mississippi east to the Suwannee River in Florida. Sporadic occurrences have been recorded as far west as the Rio Grande River between Texas and Mexico, and as far east and south as Florida Bay (Wooley and Crateau 1985; Reynolds 1993).

In the late 19th century and early 20th century, the Gulf sturgeon supported an important commercial fishery, providing eggs for caviar, flesh for smoked fish, and swim bladders for isinglass, which is a gelatin used in food products and glues (Huff 1975; Carr 1983). Gulf sturgeon numbers declined due to overfishing throughout most of the 20th century. The decline was exacerbated by habitat loss associated with the construction of dams and sills (low dams), mostly after 1950. In several rivers throughout the species' range, dams and sills have severely restricted sturgeon access to historic migration routes and spawning areas (Wooley and Crateau 1985; McDowall 1988).

On September 30, 1991, the Service and the National Marine Fisheries Service (NMFS) listed the Gulf sturgeon as a threatened species under the Act (56 FR 49653). Threats and potential threats identified in the listing rule included: construction of dams; modifications to habitat associated with dredging, dredged material disposal, de-snagging (removal of trees and their roots) and other navigation maintenance activities; incidental take by commercial fishermen; poor water quality associated with contamination by pesticides, heavy metals, and industrial contaminants; aquaculture and incidental or accidental introductions; and the Gulf sturgeon's long maturation and limited ability to recolonize areas from which it is extirpated.

The Service and NMFS conducted a 5-year status review in 2009 where we concluded that the following threats continue to affect the Gulf sturgeon and its habitat: impacts to habitats by dams, dredging, point and nonpoint discharges, climate change, bycatch, red tide, and collisions with boats (USFWS and NMFS 2009). Additional threats may include ship strikes and potential hybridization due to accidental release of non-native sturgeon. These threats persist to varying degrees in different portions of the species range. The juvenile stage of Gulf sturgeon life history is the least understood, and perhaps the most vulnerable as this cohort remains in the river for the first years of its life and is, therefore, exposed to most of the threats faced by the species and its habitat. Further, the species' long-lived, late-maturing, intermittent spawning characteristics make recovery a slow process.

Currently, seven rivers are known to support reproducing subpopulations of Gulf sturgeon. Table 4.1 lists these rivers and the most-recent estimates of subpopulation size. Abundance numbers indicate a roughly stable or slightly increasing population trend over the last decade in the eastern river systems (Florida), with a much stronger increasing trend in the Suwannee River and a possible decline in the Escambia/Conecuh River. Populations in the western portion of the range (Mississippi and Louisiana) have never been nearly as abundant, and their current status is unknown as comprehensive surveys have not occurred in the past ten years.

At this time, the Service characterizes the status of the species range wide as stable; however, the status of the subpopulations in the Pearl and Pascagoula rivers is uncertain. These rivers do not have current population estimates and have recently been threatened by hurricanes, the Deepwater Horizon oil spill, and a pot-liquor spill in the Pearl River. The Gulf sturgeon continues to meet the definition of a threatened species. While some riverine populations number in the thousands, abundance of most populations is in the hundreds. Loss of a single year class could be catastrophic to some riverine populations with low abundance. Further, while directed fisheries no longer occur, many threats continue and new ones are arising. Data are not yet available to determine if Gulf sturgeon recovery is limited by factors affecting recruitment (e.g., spawning habitat quantity or quality), adult survival (e.g., incidental catch in fisheries directed at other species), or the late-maturing, intermittent reproductive characteristics of the species.

4.1.4. Conservation Needs of and Threats to Gulf Sturgeon

At the time of the listing of the Gulf sturgeon, several threats were discussed as the reason for the decline of the species. These threats and potential threats include: modifications to habitat associated with dredging, dredged material disposal, de-snagging (removal of trees and their roots) and other navigation maintenance activities; incidental take by commercial fishermen; poor water quality associated with contamination by pesticides, heavy metals, and industrial contaminants; aquaculture and incidental or accidental introductions; and the Gulf sturgeon's slow growth and late maturation (56 FR 49653).

Dams restrict the gulf sturgeon's ability to use upstream areas past the dams for spawning because they are unable to pass through these dam systems (56 FR 49653). The Ross Barnett dam on the Pearl River and the Jim Woodruff Lock and Dam on the Apalachicola are two such dams that block the upstream migration of the species. While smaller dams such as the Poole's Bluff and Bogue Chitto Sills are passable at certain flow conditions, those small structures can still impede upstream migration. Not only do dams restrict upstream migration, they can cause altered flow, channel morphology changes, and water quality issues well downstream of their construction (USFWS 2009). Dredging activities have also led to habitat degradation for the Gulf sturgeon by modification of important channel features used for spawning and foraging. Dredging can also be detrimental to gulf sturgeon due to direct mortality from entrainment.

Although direct take of Gulf sturgeon is prohibited within the states in the current species range, risk from incidental bycatch due to entanglement in fishing and trawling gear still occurs (USFWS 2009). Shrimpers have continued to document Gulf sturgeon bycatch in shrimp trawls even with the inclusion of sea turtle and fish excluder devises on the trawls. The State of Florida has made it unlawful to use entangling nets (i.e., gill and trammel nets) in state waters and has also restricted the use of other types of nets (i.e., cast nets, seines, etc.). The implementation of these net bans has likely been a benefit to recovery for Gulf sturgeon; however, sturgeon continue to be caught in these nets in states without these types of bans or restrictions.

The threat of poor water quality, while not clearly understood, has been studied and some studies indicate the potential impacts to various life stages of Gulf sturgeon. A study in the Suwannee River by Sulak et al. (2004) indicated that for Gulf sturgeon to have successful egg fertilization a narrow range of pH and calcium ion concentration may be required. It has also been shown that egg and larval development can be vulnerable to various forms of pollution, temperature, and dissolved oxygen (DO) levels. The Bogalusa paper mill spill on the Pearl River in 2011 contributed to a large fish kill, resulting in the death of approximately 28 Gulf sturgeon most of which were juveniles (Slack et al. 2014).

Hurricanes and collisions with boats are also ongoing threats to the species. Hurricanes such as Ivan in 2004, Katrina in 2005, and most recently Michael in 2018 have shown to cause mortality of Gulf sturgeon. While the impacts of the population in the Pearl River from Hurricane Katrina are generally unknown, reports from the first few days after the storm counted at least eight dead Gulf sturgeon (Mike Beiser, MSDEQ, personal communication). After Hurricane Michael, dozens of dead Gulf sturgeon were documented by Florida Fish and Wildlife Conservation Commission (FWC) biologists (Kaeser 2019). Gulf sturgeon have been seen jumping out of the water, possibly as a form of group communication to maintain group cohesion (Sulak et al. 2002). Collisions with boats has been attributed to this jumping behavior resulting in mortality to the species, as well as posing a safety issue to boaters (USFWS 2009).

The most recent 5-year review (2009) confirmed that these threats continue to be ongoing for the Gulf sturgeon.

4.1.5. Tables and Figures for Status of Gulf Sturgeon

Table 4.1. Estimated size of known reproducing subpopulations of Gulf sturgeon. In some cases, multiple estimates are presented based on differences in population estimation models used. All estimates apply to a proportion of the population exceeding a minimum size, which varies by researchers according to the sampling method used. CI = confidence interval. NR =not reported.

River	Year of data collection	Abundance Estimate	Lower Bound 95% CI	Upper Bound 95% CI	Source
Pearl	2001	430	323	605	Rogillio et al. 2001
Pascagoula	2000	181	38	323	Ross et al. 2001
Pascagoula	2000	206	120	403	Ross et al. 2001
Pascagoula	2000	216	124	429	Ross et al. 2001
Escambia/Conecuh	2006	451	338	656	USFWS 2007
Yellow	2011	1,036	724	1,348	USFWS 2012 unpub. data
Choctawhatchee	2008	3,314	NR	NR	USFWS 2009
Apalachicola	2005	2,000	NR	NR	Pine and Martell 2009a
Apalachicola	2010	1,292	616	1,968	USFWS 2010 unpub. data
Suwannee	2004	10,000	NR	NR	Pine and Martell 2009a
Suwannee	2006	9,728	6,487	14,664	Randall 2008
Suwannee	2007	14,000	NR	NR	Sulak 2008

4.2. Environmental Baseline for Gulf Sturgeon

This section is an analysis of the effects of past and ongoing human and natural factors leading to the current status of the Gulf sturgeon, its habitat, and ecosystem within the Action Area. The environmental baseline refers to the condition of the listed species or its designated critical habitat in the Action Area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the Action Area, the anticipated impacts of all proposed Federal projects in the Action Area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 CFR §402.02).

4.2.1. Action Area Numbers, Reproduction, and Distribution of Gulf Sturgeon

Recent studies for the Gulf sturgeon have not been conducted in this reach of the Pearl River and survey data from this area is not prevalent; however, there are unconfirmed sightings of Gulf sturgeon as far upstream as the City of Jackson, Mississippi, in Hinds County which is within the Action Area (Morrow et. al. 1996; Lorio 2000; Slack, pers. comm. 2002). Just north of the Action Area at RM 301.77 is the Ross Barnett Reservoir, which presents a total barrier to migration to Gulf sturgeon (56 FR 49653). Prior to the construction of the Ross Barnett, there are records of Gulf sturgeon found in the vicinity of the dam and reservoir site as well as further upstream along the Pearl River; however, since its completion no sturgeon have been captured upstream of the dam (Morrow et al 1998; Sulak et al 2016). In 1915, the City of Jackson built a low weir at approximately RM 290.7 to provide the water supply for the city, which continues to provide a large portion of the city's water supply. This weir potentially restricts the Gulf sturgeon's access to the Action Area in low flow periods.

To address flooding in the Jackson area, the 1960 Flood Control Act authorized construction of the Jackson (i.e., Fairgrounds) and East Jackson levees which was completed in 1968. An extension of the Jackson levee was completed in 1984. This flood control project consists of those two earthen levees on either side of the river totaling 13.2 miles. There is also channel work associated with the levees which includes 9.3 miles of enlargement and realignment of the main river channel through the town of Jackson (approximately 5 miles of cutoffs). Maintenance includes any necessary periodic removal of vegetation along a 650-foot-wide cleared strip of floodplain along the river and complete clearing downstream of that; a total of 346 acres of the floodplain are maintained in some form of cleared or partially cleared floodplain. About 80 percent of the Action Area has been affected by these past flood control activities. Due to these activities, the river in this area has relatively shallow base flows except for a short time after rain events where the river will have a fairly fast, deep flow.

Most of the Gulf sturgeon surveys in the Pearl River Basin have been focused in the Lower Pearl River and the Bogue Chitto River. The Poole's Bluff and Bogue Chitto Sills in the lower part of the river system have limited the Gulf sturgeon's migration access to the reaches of the river north of these sills during low water periods; however, surveys have shown that Gulf sturgeon can and do swim past the both sills during high water periods (USFWS BRFWCO 2018). A study conducted by the Baton Rouge Fish and Wildlife Conservation Office (BRFWCO) from 2013 to 2016 assessed the Gulf sturgeon's ability to move upstream of the two sills. It was found that of the sturgeon that made the attempt to pass over the sills, 72 percent successfully passed the Poole's Bluff sill and 21 percent successfully made it over the Bogue Chitto Sill. It is uncertain if these sturgeons are navigating over or around the structures (Kohl 2003).

Scientific surveys conducted over the past three decades have collected early juveniles which demonstrates that the Pearl River still supports a spawning population, although the exact spawning locations are yet to be discovered (Sulak et al. 2016). Results from sturgeon captures in the Pearl River between 1992 and 2001 suggest a stable subpopulation of 430 fish, with approximately 300 hundred adults (Rogillio et al. 2001). With the presence of juvenile sturgeon captured during survey efforts, it leads to the indication that successful spawning takes place at some location in the Pearl River (USFWS 2003). Survey activities have primarily been focused on the lower Pearl River and the Bogue Chitto River; therefore, the data for gulf sturgeon in this reach of the river, approximately 19.37 miles, in the Action Area are minimal and typically consist of sporadic captures by commercial fishermen (Table 4.2). Although these records are not from scientific surveys, the commercial data indicate that sturgeon are migrating north of the Poole's Bluff Sill, into the upper reaches of the Pearl River, approximately every 3.4 years, due to water levels at the sill occurring at passible levels for the sturgeon. As scientific surveys have not been conducted in this reach of the river, the sporadic captures from Table 4.2 do not give a good indication of sturgeon density in this reach of the river; the density is at this time not fully known. As shown in Table 4.2, there have been 24 Gulf sturgeon captured by commercial fishermen, eight of which being captured within the Action Area and the most recent of those captures occurring, a juvenile, in 2008. Adult sturgeon have also been captured by commercial fisherman downstream of the Action Area near the Strong River's confluence with the Pearl River during spawning season leading to the possibility that adults that make it past the Poole's Bluff Sill come at least as far as the Strong River to spawn (BRFWC 2019 pers. comm.). The Service suspects that the only true suitable spawning habitat is found north of both sills on the Pearl River and the Bogue Chitto River, but the habitat is only accessible during high flow periods (USFWS 2003). That same area of the river, north of the sill, is also thought to have the gravel substrate necessary for spawning in the Pearl River.

4.2.2. Action Area Conservation Needs of and Threats to Gulf Sturgeon

The Action Area consists of approximately 231 acres of riverine habitat that would be impacted by the project. This impacted area of the river consists of habitat that Gulf sturgeon could use to either spawn as adults or feed as juveniles if they migrate to that reach of the river; however, suitable spawning habitat is believed to be further south of the Action Area. The status of the Gulf sturgeon in the Action Area has been influenced by past channelization and a 200–foot-wide weir structure that supplies the City of Jackson with water. The past channelization and levee construction isolate 5.34 miles of Pearl River meanders. These previous actions have reduced the amount of river habitat available for the species, including reductions in foraging and spawning areas. The degraded water quality from pollution and storm water runoff into the

Pearl River in the Action Area could also have impacted the Gulf sturgeon populations in this area. The section of river north of the water supply weir is accessible in high water events; however, in times of low water the species are not able to migrate past the structure. Downstream of the 200–foot-wide weir is a ring levee around the Savannah Street Wastewater Treatment Plant. The levee surrounding this plant has, during high water events, overtopped and stormwater has spilled into the river; however,but the plant's containment system would be upgraded during the Action to prevent this from occurring in the future. In the area just north of the Action Area, the Ross Barnett Reservoir has resulted in an obstruction to Gulf sturgeon migration further up the Pearl River. Suitable spawning habitat for this species is thought to be south of the Action Area on the Pearl River near its confluence with the Strong River due to the substrate of the river bottom at that location.

In May of 2019, the MDEQ issued a water quality advisory for the Pearl River in Jackson due to ongoing sanitary sewer overflows around the City of Jackson discharging wastewater into various waterbodies that flow into the river (MDEQ 2019). There are two former landfills (Gallatin Street and Jefferson Street) and the former Gulf States Creosote Plant that are located within the proposed project area. The 62-acre Gallatin Street landfill contains urban and industrial trash. Leachates from within the site contain cadmium, lead, and nickel above the regulatory standards. Debris from this landfill is reported to be washing into the river. The 45-acre Jefferson Street (or Lafleurs Landing) landfill also has debris that can be eroded during high river stages. The EPA's PSA/SI done in 2003 found barium, cobalt, managanese, and zinc, as well as creosote residuals consisting of a variety of polycyclic aromatic hydrocarbons (PAHs).

According to the 2009 5-year review, the population of Gulf sturgeon in the Pearl River is stable (USFWS 2009). Most of the survey data comes from the lower reach of the river, but studies show that there is recruitment in the river. However, this information does not provide population or capture data for the Action Area. The evidence of presence for the species in the Action Area is based on commercial data from fishermen capturing the species in hoop nets as discussed in Section 4.2.1. Scientific surveys would be needed to accurately quantify population numbers in the Action Area.

4.2.3. Tables and Figures for Environmental Baseline for Gulf Sturgeon

Table 4.2. Historic Gulf sturgeon captures north of the Poole's Bluff Sill. Note: Records in *Italics* are in the Action Area, while records from below the Action Area are not italicized.

Year	Location	Age Class	Capture Method	Captured By	Source
1939	*Upper Pearl River, above Pools Bluff Sill, Pearl River, north of Jackson MS*	*Adult*	*Unknown*	*Unknown*	*Morrow et al. 1996*
1940	*Pearl River N. Jackson MS*	*Unkown*	*Unknown*	*Unknown*	*Lafayette Printed Database*

1940	Upper Pearl River, above Pools Bluff Sill, Rockport, MS	Unknown	Unknown	Unknown	Morrow et al. 1996
1942	*Pearl River N. Jackson MS*	*Unknown*	*Unknown*	*Unknown*	*Lafayette Printed Database*
1942	*Upper Pearl River, above Pools Bluff Sill, Pearl River, north of Jackson MS*	*Unknown*	*Unknown*	*Unknown*	*Morrow et al. 1996*
1953	Strong River near Caney Creek	Adult	Unknown	Fisherman	www.fffmag.com; August 2001
1971	*Upper Pearl River, above Pools Bluff Sill, Below Spillway of Ross Barnett Res.*	*Adult*	*Unknown*	*Unknown*	*Morrow et al. 1996*
1976	*Pearl River- below Ross Barnett Reservoir spillway*	*Adult*	*Unknown*	*Commercial fisherman*	*Gulf Sturgeon Recovery Plan 1995*
1979	*Pearl River below spillway of Ross Barnet Res.*	*Unknown*	*Unknown*	*Unknown*	*Lafayette Printed Database*
1982	Pearl River Monticello MS	Unknown	Unknown	Unknown	Lafayette Printed Database
1982	Upper Pearl River, above Pools Bluff Sill, Pearl River at Monticello MS	Adult	Unknown	Unknown	Morrow et al. 1996

1982	Upper Pearl River, above Pools Bluff Sill, Pearl River at Monticello MS	Juvenile	Unknown	Unknown	Morrow et al. 1996
1982	Upper Pearl River, above Pools Bluff Sill, Pearl River at Monticello MS	juvenile	unknown	unknown	Morrow et al. 1996
1983	Pearl River Monticello MS	Unknown	Unknown	Unknown	Lafayette Printed Database
1984	Upper Pearl River, above Pools Bluff Sill, Pearl River at Byram, MS	Unknown	Unknown	Unknown	Morrow et al. 1996
1984	Upper Pearl River, above Pools Bluff Sill, Pearl River at Byram, MS	Unknown	Unknown	Unknown	Lafayette Printed Database
1985	Pearl River between Wanilla and Rockport	Unknown	Hoop net	Unknown	Slack pers. Comm.
1993	Upper Pearl River, above Pools Bluff Sill, Strong River, MS	Adult	Unknown	Unknown	Morrow et al. 1996
1996	Pearl River south of Georgetown, MS	Adult	Hoop net	Fisherman	Knight 1996
2000	Pearl River near Georgetown, MS	Unknown	Hoop net	Unknown	Slack pers. Comm.

2002	Red Bluff Creek, North of Morgantown, MS	Unknown	Hoop net	Unknown	Slack pers. Comm.
2008	*Below Ross Barnett Reseroir*	*Juvenile*	*Rod and reel*	*Fisherman*	*Slack pers. Comm.*
2018	Pearl River between Wanilla and Rockport	2 Adults	Hoop net	Commercial fisherman	Mann pers. Comm.

4.3.Effects of the Action on Gulf Sturgeon

This section analyzes the effects of the Action on the Gulf Sturgeon. Effects of the Action are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the Action may occur later in time and may include consequences occurring outside the immediate area involved in the Action (50 CFR §402.02).

Our analyses are organized according to the description of the Action and the defined Action Area in section 2 of this BO.

4.3.1. Effects of Channel Excavation and Levee Relocation on Gulf Sturgeon

Approximately 207.7 acres of open water would be impacted by the channel excavation and levee relocation. Channel excavation and levee relocation would occur on the outer banks with approximately 100 feet of buffer area between the bank excavation and the river to retain some bank stability. The excavation is projected to occur during the low water periods of the year; however, while the excavation and levee relocation construction activities are being conducted, the disturbance to the sediment would increase the turbidity in the river. During the construction period and until a vegetative cover is established on the levees, the levees and all disturbed areas would be subject to erosion. This eroded material would be carried into small tributary streams and into the Pearl River system. The turbidity would be additive to any downstream riverbank erosion resulting from sediments being trapped behind the weir after its construction. Increased sediment and turbidity can result in decreased light penetration and decreased photosynthesis. High levels of sediment can settle on fish spawning areas and smother fish eggs and larvae. Production of benthic organisms also can be reduced by high levels of sediment. Further, sediments can settle on respiratory surfaces of fish and aquatic organisms and interfere with respiration.

Sulak et al (2016) found it difficult to quantify indirect mortality impacts from natal river habitat alterations including channelization, dredging, impoundments, and bulk heading. This uncorrected and/or uncontrolled alteration of Gulf sturgeon habitat could limit the success of a promising year-class at various stages in the Gulf sturgeon life cycle. Kynard and Parker (2004) found that while juveniles are mostly bottom feeders, they also spent an unusual amount of time in a holding pattern in the water column suggesting that when benthic foraging in the river is scarce, juvenile fish have evolved to drift feed. If this assumption is correct, should the water quality affect the benthic macroinvertebrates in the Action Area, the foraging juveniles could move up in the water column to drift feed. Areas that have high concentrations of suspended sediments show a decrease in macroinvertebrate diversity, especially the more sensitive species (Sawyer et al 2004). Studies from other regions indicate that sedimentation decreases available spawning habitat, increases egg and larvae mortality, and can decrease feeding success of species that rely on visual search strategies (Sawyer et al. 2004; Berman and Rabeni 1987; Henley et al. 2000). The increased sedimentation and turbidity in the river from the channel excavation and levee relocation would have impacts on the macroinvertebrate prey for any juvenile Gulf sturgeon that would be temporarily feeding in the Action Area.

4.3.2. Effects of Weir Construction and Impoundment on Gulf Sturgeon

With the construction of the 1,500-foot-wide weir structure and resulting impoundment from the weir, changes to the velocity and water surface elevation would occur within the Action Area. The weir has been designed to match the current discharge of the river; therefore, there should not be significant change in discharge after the target area has filled to the top of the weir. Low-head dams, such as weirs, impede migratory pathways of fish including the Gulf sturgeon. As a way for fish to move past the weir, a fish passage channel would be constructed east of the weir and low flow structure.

During the construction of the weir, low flow structure, and fish passage channel, there would be similar impacts to Gulf sturgeon as those associated with the channel excavation and levee relocation. These impacts include increased sedimentation, increased turbidity, and bank destabilization. Excavation of the area for the weir site, low flow structure, and fish passage channel is necessary, but would potentially cause excess sediment to flow downstream approximately 1.6 miles south of the construction area and erosion could be exacerbated in that area until the riverbank has stabilized. See Section 4.3.1 for more information regarding the effects of sedimentation and turbidity.

Dams or impoundments are thought to be one of the main obstacles to Gulf sturgeon recovery in the Pearl River (Sulak et al. 2016). Low-head barrier dams such as the proposed weir structure have consistent influences on stream-fish assemblages which have shown longitudinal declines in species richness from below to above barriers and result in altered population dynamics of a species (Porto et al. 1999; Pringle 1997). Impoundments confine spawning and YOY nursery/feeding habitat to the unimpounded reaches of the river below the dams. In the lower Pearl River, the Poole's Bluff Sill blocks access to the river north of the structure during low river stages; however, when the water is high Gulf sturgeon are able to move past the structure (BRWFCO 2018). The migratory blockage caused by the weir structure could impact the sturgeon's ability to swim north of the structure unless there are high water events; however, a fish passage channel has been included as part of the project design to minimize the impacts on aquatic species migration.

Impoundments/dams generally have adverse impacts to riverine fish communities by interrupting migratory movements. With the addition of the fish passage channel in the design of the project, impacts may be minimized to Gulf sturgeon migration providing that flow conditions would meet the needs of the species to be able to navigate the passage. These conditions include water velocity that does not exceed the sturgeon's swim speed and enough water flow levels for the species to be able to swim through it. Studies have shown that Gulf sturgeon cannot swim against currents greater than 1 to 2 meters per second (mps) (3 to 6 fps); however, they can swim up to 2 to 2.5 body lengths per second (Boyd Kynard, pers.comm. 2003; Kohl 2003; Wakefield 2001). Studies on fish passage attraction speed flow has shown that the recommended flow should be between 2 and 4 fps with sustained swim speed ranges for sturgeon to be in the range of 3 to 4 fps (Cheong et al. 2006; White and Mefford 2002). The swimming capabilities of juvenile sturgeon has been tested, and it was documented that juveniles less than 6 inches long can swim at velocities up to 1 mps (3 fps) (Kohl 2003). At this time, there is only a conceptual model of the fish passage channel, approximately 1.4 miles long of a curving channel, with the possible velocities ranging anywhere from 1 to 7 fps. The maximum velocity of 7 fps would push the limits of adult Gulf sturgeon's ability to swim against the current and any juveniles attempting to migrate through the passage would be unable to swim through it. However, depending on where in the channel the velocities would occur at that speed the fish may be able to migrate successfully through it; therefore, the proposed passage feature should be monitored for water velocity and water level conditions.

Water velocity is an important factor in the life-cycle of Gulf sturgeon. During spawning, flows that are too strong would prevent eggs from settling on and adhering to suitable substrate, while flows that are too low could cause clumping of the eggs and lead to increased mortality from fungal infection and asphyxiation (Wooley and Crateau 1985; USFWS 2003). A study performed by Flowers et al. (2009) on the Apalachicola River presented evidence that flow regime and water velocity influence Gulf sturgeon spawning by stimulating the adults to move to spawning grounds. These flow regimes and water velocities also structure and modify substrate to create suitable areas for egg attachment and provide adequate oxygenation for egg survival (Auer 1996; Fox et al. 2000). Optimal spawning site flows generally are high and have a continuous rate of current flow, approximately > 4.9 fps. There are no spawning sites documented in the Action Area, and although recruitment occurs in the Pearl River, the actual site(s) where spawning occurrs is unknown at this time.

According to the 1995 Gulf Sturgeon Recovery Plan, Wooley and Crateau (1985) reported that sturgeon in the Apalachicola River around the Jim Woodruff Lock and Dam have been found in depths of 19.7 to 39.4 ft and at velocities ranging from 2 to 3 fps during the summer months. The low flow structure is designed to meet the same required discharge as the Ross Barnett dam, which would allow for no change in the current discharge due to the project. Table 2.1 shows the average monthly discharges from 1966 to 2013, indicating that June through October typically have the lowest discharges and December through April typically have the highest discharges. While the velocities in the Action Area will be modified due to the project, discharges are anticipated to remain the same because the project design matches the flow of the

Ross Barnett dam. Because the current flows would remain the same according to project design and sturgeon have been captured by commercial fishermen in the Action Area previously at the similar flow regime, impacts to sturgeon in the area would be minimal.

An examination of low-head dams determined that the major issue resulting from such structures is alterations in water temperature caused by anthropogenic influences impacting water quality within the created water body (Cummings 2004). In water, temperature influences other water quality factors such as DO and pH in the water column. In freshwater, when the temperature increases the pH decreases (Kishinhi et al. 2006). Kishinhi et al. (2006) studied the water quality in the Pearl River around Jackson, Mississippi, and in the Ross Barnett Reservoir and found that the mean pH values at all of the sampling sites were within the State's recommended range of 6.0 to 9.0. The optimal pH for sturgeon eggs generally lies in the range of nearly neutral (pH=7.0) to slightly alkaline (pH<8.0) (Sulak et al. 2016). Although water quality parameters were modeled for pre- and post-project, it did not include a model specifically for pH. However, temperature was modeled, and although there were slight differences, none were significantly different from current ranges (Table 2.7). Therefore, we can infer that the pH would not have significant changes post project.

Dissolved oxygen levels are also important water quality aspects for feeding and the survival of juvenile sturgeon. Secor and Gunderson (1997) studied the effects of temperature and DO on juvenile Atlantic sturgeon (*Acipenser oxyrinchus*). According to this sturdy, reduced oxygen levels resulted in a threefold reduction in growth rate and a reduction in routine respiration rates. Juveniles were more vulnerable to low DO levels and high temperatures; however, in spite of reduced respiration and survival, they continued to feed and grow through reduced activity to allocate more energy to growth. Although specific DO tolerance levels have not been established for the Gulf sturgeon, hypoxia for other *Acipenser* species have been documented to start at 4 milligrams per liter (mg/L) (Cech et al. 1984; Jenkins et al. 1993; Kahn and Mohead 2010; Secor and Gunderson 1998). The DO levels for the Pearl River and Ross Barnett Reservoir were monitored by Kishinhi et al. (2006); the lowest levels of DO occurred in August at 5 mg/L and the highest levels occurred in December at 20 mg/L. The mean concentrations of DO for that study were normally above the minimum of 5 mg/L recommended by the MDEQ for the protection of aquatic life. As with the pre- and post-project water quality modeling for temperature, DO was modeled with slight but not significant differences from pre–project conditions. High temperatures and lower DO levels would be likely to occur during the summer months when juvenile Gulf sturgeon would use the area for feeding, but DO levels for this area are projected to be minimally changed post-project and the levels should not drop below the tolerance for juveniles (Table 2.7). Should the DO levels drop below 4 mg/L, the juveniles would be stressed from the lower levels, however, it is possible they would continue to feed but reduce activity to have the ability to continue to grow.

4.3.3. Effects of Non-Federal Activities caused by the Federal Action on Gulf Sturgeon

With the improved channel, recreational water sports (e.g., fishing and boating) will be expected to increase as a result of the improved access to the Action Area. This increase in fishing could lead to more incidental captures of Gulf sturgeon in hoop nets or with rods and reels if sturgeon migrate past the weir through the fish passage channel. Because the Service does not know the degree to which recreational uses will increase, we are unable to estimate the number of sturgeon that could be impacted due to the increase in fishing.

An increase in development adjacent to the improved channel could also lead to a decrease in water quality which would, in turn, impact prey sources and juvenile growth. Although changes in water quality could be measured, estimating the amount or extent of those changes to prey resources and juvenile growth are difficult to predict or anticipate. The relocation or retrofitting of existing infrastructure within the Action Area (i.e., roads, bridges, pipelines, transmission lines) would also lead to a decrease in water quality during construction of such actions, although such impacts would be temporary. These impacts to water quality would include increased sedimentation and turbidity from any excavation in or around the river. This increased sedimentation and turbidity would have the same impacts to sturgeon as discussed in Section 4.3.1.

4.3.4 Summary of Effects of the Action on Gulf Sturgeon

The Poole's Bluff Sill hinders sturgeon migration upriver and sturgeon can only pass that sill during high water events. Based on best available data and the probability of high water events coinciding with northward riverine migration, we estimate that only 0.9 percent of the Pearl River population can access river habitat north of the sill on any given year. Individually, the separate activities of the Action will likely not harm sturgeon in the Action Area; however, collectively the compounding effects of all the activities are likely to rise to the level of harm. Thus, we estimate that the collective activities of the entire Action would disturb a maximum of 4 sturgeon per year to the level of harm. Given that construction would last up to 5 years, the maximum number of sturgeon affected by the Action would be 20 fish (4.6 percent of the Pearl River population).

4.4. Cumulative Effects on Gulf Sturgeon

For purposes of consultation under ESA §7, cumulative effects are those caused by future state, tribal, local, or private actions that are reasonably certain to occur in the Action Area. Future Federal actions that are unrelated to the proposed action are not considered, because they require separate consultation under §7 of the ESA. At this time the Service is unaware of any future state, tribal, local, or private non-Federal unrelated to the proposed action that are reasonably certain to occur in the Action Area. Therefore, cumulative effects are not relevant to formulating our opinion for the Action.

4.5. Conclusion for Gulf Sturgeon

In this section, we summarize and interpret the findings of the previous sections for the Gulf sturgeon (status, baseline, effects, and cumulative effects) relative to the purpose of a BO under §7(a)(2) of the ESA, which is to determine whether a Federal action is likely to:

a) jeopardize the continued existence of species listed as endangered or threatened; or
b) result in the destruction or adverse modification of designated critical habitat.

"*Jeopardize the continued existence*" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR §402.02).

The Action would alter 9.5 river miles of Gulf sturgeon habitat in the Pearl River. Increased sedimentation and turbidity from the construction of the weir and fish passage channel, as well as erosion during the excavation phase of the approximately 5-year project would decrease the macroinvertebrates in the area. This decrease in food sources could lead any juveniles in the area to possibly leave in search of sustenance. The increased turbidity and sedimentation caused by all of the construction actions including the retrofitting or relocation of existing infrastructure would be temporary; therefore, as Gulf sturgeon are highly mobile and can avoid these areas, any effects on their overall health would be minimal. After construction has been completed, it is probable that sturgeon could return to the area as long as it is a year when water flow is high enough to migrate past the Poole's Bluff Sill that occurs downstream.

The anticipated changes in DO from the impoundment would impact any juveniles foraging in the area as well as their prey base. The reduction in water quality from lower DO levels would impact any foraging sturgeon in the area, but they are known to reduce activity to conserve energy to feed and grow in periods of low DO.

The weir structure will possibly cause migration issues for the sturgeon; however, a fish passage feature has been designed for just downstream of the weir. The construction of the fish passage channel would increase the possibility of sturgeon having the ability to return to the area should they migrate into that reach of the river.

The various stressors and forms of disturbance from the Action, considered separately, are not likely to cause harm of sturgeon found in the Action Area. However, considered collectively, the combined level of stressors and disturbances could result in harm to a maximum of 20 sturgeon (4.6 percent of the Pearl River population) utilizing the Action Area. The status of the subpopulation of Gulf sturgeon in the Pearl River has been shown to be stable. Our analysis indicates that while the Action would have a negative effect on those 20 sturgeon, such effects to 4.6 percent of that subpopulation would not be appreciable for the survival and recovery of the Gulf sturgeon.

After reviewing the current status of the species, the environmental baseline for the Action Area, the effects of the Action and the cumulative effects, it is the Service's biological opinion that the Action is not likely to jeopardize the continued existence of the **GULF STURGEON**.

5. CRITICAL HABITAT FOR GULF STURGEON

5.1. Status of Gulf Sturgeon Critical Habitat

This section summarizes best available data about the current condition of all designated units of critical habitat for Gulf sturgeon that are relevant to formulating an opinion about the Action. The Service published its decision to designate critical habitat for Gulf sturgeon on March 19, 2003 (68 FR 13370 13495). The most recent 5-year status review of the species was completed September 22, 2009.

5.1.1. Description of Gulf Sturgeon Critical Habitat

The Service and NOAA Fisheries jointly designated Gulf sturgeon critical habitat on April 18, 2003 (68 FR 13370, March 19, 2003). Gulf sturgeon critical habitat includes areas within the major river systems that support the seven currently reproducing subpopulations and associated estuarine and marine habitats. Gulf sturgeon use rivers for spawning, larval and juvenile feeding, adult resting and staging, and moving between the areas that support these life history components. Gulf sturgeon use the lower riverine, estuarine, and marine environment during winter months primarily for feeding and, more rarely, for inter-river movements.

Fourteen areas (units) are designated as Gulf sturgeon critical habitat (Figure 5.1). Critical habitat units encompass approximately 2,783 km (1,729 mi) of riverine habitats and 6,042 square km (km^2) (2,333 square miles) of estuarine and marine habitats, and include portions of the following Gulf of Mexico rivers, tributaries, estuarine and marine areas:

Unit 1	Pearl and Bogue Chitto Rivers in Louisiana and Mississippi;
Unit 2	Pascagoula, Leaf, Bowie, Big Black Creek and Chickasawhay Rivers in Mississippi;
Unit 3	Escambia, Conecuh, and Sepulga Rivers in Alabama and Florida;
Unit 4	Yellow, Blackwater, and Shoal Rivers in Alabama and Florida;
Unit 5	Choctawhatchee and Pea Rivers in Florida and Alabama;
Unit 6	Apalachicola and Brothers Rivers in Florida;
Unit 7	Suwannee and Withlacoochee River in Florida;
Unit 8	Lake Pontchartrain (east of causeway), Lake Catherine, Little Lake, the Rigolets, Lake Borgne, Pascagoula Bay and Mississippi Sound systems in Louisiana and Mississippi, and sections of the state waters within the Gulf of Mexico;
Unit 9	Pensacola Bay system in Florida;
Unit 10	Santa Rosa Sound in Florida;
Unit 11	Nearshore Gulf of Mexico in Florida;
Unit 12	Choctawhatchee Bay system in Florida;
Unit 13	Apalachicola Bay system in Florida; and
Unit 14	Suwannee Sound in Florida.

Critical habitat designation for the Gulf sturgeon used the term "primary constituent elements" (PCEs) to identify the key components of critical habitat that are essential to its conservation and may require special management considerations or protection. Revisions to the critical habitat regulations in 2016 (81 FR 7214, 50 CFR §4.24) discontinue use of the term PCEs, and rely exclusively the term "physical and biological features" (PBFs) to refer to these key components, because the latter term is the one used in the statute. This shift in terminology does not change how the Service conducts a "destruction or adverse modification" analysis. In this BO, we use the term PBFs to label the key components of critical habitat that provide for the conservation of the Gulf sturgeon that were identified in its critical habitat designation rule as PCEs. The PBFs of Gulf sturgeon critical habitat are (68 FR 13370 13495):

- Abundant food items, such as detritus, aquatic insects, worms, and/or mollusks, within riverine habitats for larval and juvenile life stages; and abundant prey items, such as amphipods, lancelets, polychaetes, gastropods, ghost shrimp, isopods, mollusks and/or crustaceans, within estuarine and marine habitats and substrates for subadult 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, subadult, 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 for maintaining spawning sites in suitable condition for egg attachment, egg sheltering, resting, and larval 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., an unobstructed river or a dammed river that still allows for passage).

The following types of Federal actions, among others, may destroy or adversely modify critical habitat:

- Actions that would appreciably reduce the abundance of riverine prey for larval and juvenile sturgeon, or of estuarine and marine prey for juvenile and adult Gulf sturgeon, within a designated critical habitat unit, such as dredging; dredged material disposal; channelization; in-stream mining; and land uses that cause excessive turbidity or sedimentation;
- Actions that would appreciably reduce the suitability of Gulf sturgeon spawning sites for egg deposition and development within a designated critical habitat unit, such as impoundment; hard-bottom removal for navigation channel deepening; dredged material disposal; in-stream mining; and land uses that cause excessive sedimentation;
- Actions that would appreciably reduce the suitability of Gulf sturgeon riverine aggregation areas, also referred to as resting, holding, and staging areas, used by adult, subadult, and/or juveniles, believed necessary for minimizing energy expenditures and possibly for osmoregulatory functions, such as dredged material disposal upstream or directly within such areas; and other land uses that cause excessive sedimentation;
- Actions that would alter the flow regime (the magnitude, frequency, duration, seasonality, and rate-of -change of fresh water discharge over time) of a riverine critical

habitat unit such that it is appreciably impaired for the purposes of Gulf sturgeon migration, resting, staging, breeding site selection, courtship, egg fertilization, egg deposition, and egg development, such as impoundment; water diversion; and dam operations;

- Actions that would alter water quality within a designated critical habitat unit: including temperature, salinity, pH, hardness, turbidity, oxygen content, and other chemical characteristics, such that it is appreciably impaired for normal Gulf sturgeon behavior, reproduction, growth, or viability, such as dredging; dredged material disposal; channelization; impoundment; in-stream mining; water diversion; dam operations; land uses that cause excessive turbidity; and release of chemicals, biological pollutants, or heated effluents into surface water or connected groundwater via point sources or dispersed non-point sources;
- Actions that would alter sediment quality within a designated critical habitat unit such that it is appreciably impaired for normal Gulf sturgeon behavior, reproduction, growth, or viability, such as dredged material disposal; channelization; impoundment; instream mining; land uses that cause excessive sedimentation; and release of chemical or biological pollutants that accumulate in sediments;
- Actions that would obstruct migratory pathways within and between adjacent riverine, estuarine, and marine critical habitat units, such as dams, dredging, point-source-pollutant discharges, and other physical or chemical alterations of channels and passes that restrict Gulf sturgeon movement (68 FR 13399).

5.1.2. Conservation Value of Gulf Sturgeon Critical Habitat

The 14 riverine and estuarine/marine habitats were included in the designation because it is believed that with proper management and protection, they collectively represent the habitat that is necessary for the conservation of the species (68 FR 13370, March 19, 2003). These selected units were chosen to be designated because they are areas that contain one or more of the PBFs essential to the species. The analysis of this Biological Opinion focuses on the riverine units of critical habitat, therefore, the 7 estuarine/marine units will not be discussed further.

Unit 1

The Pearl River distributaries are used for migration to spawning grounds, summer resting holes, and juvenile feeding (68 FR 13370, March 19, 2003). The presence of juvenile sturgeon in the river system indicates successful spawning at some location in the river system. The only suitable spawning habitat believed to occur in the Pearl River system occurs north of the sills on the Pearl River and Bogue Chitto River with access to these areas limited only to periods of high flows (Morrow et al. 1996; Morrow et al. 1998). The typical bedrock and limestone outcroppings preferred for spawning in other river systems do not occur in the Pearl River system; however, sturgeon spawning areas in the Pearl drainage likely include soapstone, hard clay, gravel and rubble areas, and undercut banks adjacent to these substrates (W. Slack pers. comm. 2001). Even though upstream movement is blocked by Poole's Bluff Sill during periods of low water, potential spawning sites have been identified upstream of the sill at various locations between Monticello, Lawrence County, Mississippi, and the Ross Barnett Dam spillway, Hinds and Rankin Counties, Mississippi (F. Parauka, pers. comm. 2002) and sturgeon have been reported as far upstream as Jackson, Hinds County, Mississippi (Morrow et al., 1996;, Lorio 2000; W. Slack pers. comm. 2002). Suitable spawning habitat occurs within the Bogue Chitto River upstream of the Bogue Chitto Sill (W. Slack pers. comm. 2001; W. Granger, FWS, pers. comm. 2002; F. Parauka pers. comm. 2002) and juvenile, adult, and subadult sturgeon have been documented on the Bogue Chitto as far upriver as 1 mile north of Quinn Bridge (Mississippi State Highway 44), McComb, Pike County, Mississippi (W. Slack pers. comm. 2001; D. Oge, Louisiana Department of Environmental Quality, pers. comm. 2002; F. Parauka, pers. comm. 2002); therefore, the main stem of the Bogue Chitto River upstream of the Quinn Bridge to Mississippi State Highway 570 has been included in this unit.

Unit 2

The subpopulation of the Pascagoula River, based on captures in summer holding areas, ranges between 162 and 216 sturgeon; however, these estimates are primarily based on large fish and do not account for juvenile or subadult fish (Heise et al. 1999; Ross et al. 2001; S. Ross USM pers. comm. 2001). The only confirmed spawning area in the Pascagoula River drainage occurs on the Bouie River and was confirmed via egg collection in 1999 (Slack et al. 1999; Heise et al. 2004; Sulak et al. 2016). Gulf sturgeon have been documented using the downstream area of the Bouie River as a summer holding area (Ross et al. 2001). The documented sightings of sturgeon and identified suitable spawning habitat upstream to Mississippi Highway 588 (Reynolds 1993; W. Slack pers. comm. 2002; F. Parauka pers. comm. 2002), confirmed use as a migratory corridor, and confirmed use by juvenile sturgeon are the reasons for the inclusion of the Leaf River in this unit. The Chickasawhay River has had documented sightings of sturgeon, presence of suitable spawning habitat, and migratory movement of sturgeon (Miranda and Jackson 1987; Reynolds 1993; Ross et al. 2001). The West and East distributaries of the Pascagoula River are used by Gulf sturgeon during spring and fall migrations. Big Black Creek and the Pascagoula River have had documented summer resting areas.

Unit 3

Larval sightings and suitable spawning habitat have been reported on the Conecuh River and spawning confirmed between River Mile 100 and 105.6 (Parauka and Giorgianni 2002; N. Craft, Florida Department of Environmental Protection pers. comm. 2001). At five sites along the Escambia River, between rkms 161-170 (RM 100-105), eggs have been collected (Craft et al. 2001; Sulak et al. 2016). The Sepulga River has been described as having smooth rock walls, and long pools with stretches of rocky shoals and sandbars which makes for suitable spawning habitat for the Gulf sturgeon (Estes et al. 1991). Scour holes in the lower Escambia River have been found as holding areas for Gulf sturgeon (Stewart et al. 2012; Sulak et al. 2016). It is believed that Gulf sturgeon likely use the Escambia River main stem and all the distributaries for exiting and entering the Escambia/Conecuh River as the use of distributaries in other systems for this purposes has been documented.

Unit 4

Multiple areas of limestone outcrops have been documented as possible spawning sites on the Yellow River because YOY sturgeon are observed near these types of riverine features, which also confirms that reproduction is occurring in this subpopulation (Parauka and Giogianni 2002; Craft et al. 2001). Potential summer resting areas along the main stem of the Yellow River have also been identified. Shoal River summer resting habitats have been confirmed (Lorio 2002), as well as summer resting and staging sites on the Blackwater River main stem and between the Wright and Cooper Basins (Reynolds 1993; Craft et al. 2001).

Unit 5

Suitable spawning habitat has been identified from the Elba Dam to the Pea River with one confirmed spawning location; however, the Elba Dam blocks sturgeon migration further upstream at all flow conditions (Parauka and Girgianni 2002; Hightower et al. in press). The lower reaches of this river system have often been used for summer resting (Fox et al. 2000). The main stem of the Choctawhatchee River has had several spawning sites and resting area identified with male Gulf sturgeon in spawning condition found near these areas (Parauka and Giorgianni 2000; H. Blalock-Herod, FWS pers comm 2002; Hightower et al. in press). With the capture of sturgeon in the Indian River, Cypress River, and Bells Leg during March and April, it is likely that sturgeon are using these tributaries as migratory corridors to and from the Choctawhatchee River main stem.

Unit 6

With the construction of the Jim Woodruff Lock and Dam in the 1950s, the Gulf sturgeon was restricted to the portion of the Apalachicola River downstream of the dam. Resting aggregations and successful spawning has been confirmed at the base and just downstream of the dam (Sulak et al. 2016; Pine et al. 2006; Scollan and Parauka 2008; Parauka and Giogianni 2002; Wooley et al. 1982). The Brothers River has been documented to have sturgeon use the area as a resting and possible osmoregulation area before migrating into estuarine and marine habitats for winter feeding (Wooley and Crateau 1985).

Unit 7

Spawning sites within the river have been confirmed with the collection of eggs on artificial substrate (Marchant and Shutter 1996; Sulak and Clugston 1999) with YOY sturgeon having been documented in the river system (Carr et al. 1996; Sulak and Clugston 1999; K. Sulak, pers. comm. 2002; Clugston, pers. comm. 2002). Multiple resting areas throughout the Suwannee River have been discovered as well (Foster and Clugston 1997). Gulf sturgeon adults use the East Pass and West Pass for emigration and immigration (Mason and Clugston 1993; Edwards et al., in prep.). Telemetry data for the Suwannee River found that male Gulf sturgeon enter the river in late January to mid-February and rapidly swim to the staging areas just below the upriver spawning grounds (USGS-WARC, unpublished telemetry database; Sulak et al. 2016). For all of these reasons these areas were included in this unit.

5.1.3. Tables and Figures for Status of Gulf Sturgeon Critical Habitat

Figure 5.1. Designated critical habitat and historical range of Gulf sturgeon.

5.2. Environmental Baseline for Gulf Sturgeon Critical Habitat

This section is an analysis of the effects of past and ongoing human and natural factors leading to the current status of designated critical habitat for Gulf sturgeon within the Action Area. The environmental baseline refers to the condition of the listed species or its designated critical habitat in the Action Area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the Action Area, the anticipated impacts of all proposed Federal projects in the Action Area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 CFR §402.02).

5.2.1. Action Area Conservation Value of Gulf Sturgeon Critical Habitat

Two of the seven PBFs identified for Gulf sturgeon critical habitat (see section 5.1.1) do not occur in the Action Area: riverine spawning sites and riverine aggregation (resting) areas. Spawning sites and aggregation areas are thought to be downstream of the Action Area (see section 4.2.1). The PBFs found in the Action Area are food, flow regime, water quality, sediment quality, and migratory pathways.

The Action Area occurs on the Pearl River around Jackson, MS. The Pearl River is included in Critical Habitat Unit 1, the Pearl and Bogue Chitto Rivers in Louisiana and Mississippi, which is currently known to support a reproducing subpopulation of Gulf sturgeon. Unit 1 consists of a total of 494 miles. The Action Area occurs at the top extent of this Critical Habitat Unit. This section of the river has been previously altered throughout the 20th century by channelization and dredging of the river, levee systems, and a weir for the water supply of the City of Jackson. As discussed in Section 4, the Ross Barnett Reservoir prevents Gulf sturgeon migration north of the reservoir. The City of Jackson water supply weir can impede sturgeon migration up to the Ross Barnett dam except in high flow events. On the Lower Pearl River, the Poole's Bluff Sill, a low-head dam, also serves as an impediment to sturgeon migration to the upper reaches of the river except in high water events.

While adult sturgeon do not usually feed in freshwater, juveniles forage extensively in rivers on aquatic insects, worms, and mollusks (Mason and Clugston 1993; Huff 1975; Sulak and Clugston 1999). A specific study of the macroinvertebrates (i.e., detritus, aquatic insects, worms, and/or mollusks) has not been conducted; however, with the varying aquatic species within the Action Area that feed on those types of prey it can be assumed that the area does contain enough of these prey items to support the populations of species that inhabit the area.

This area of the Pearl River has been altered in the past by dredging and channelization, losing 5.34 miles of meanders. Suitable spawning substrate within the Pearl River likely includes soapstone, hard clay, gravel, and rubble areas and undercut banks adjacent to these substrates (W. Slack, pers. comm. 2001). Specific surveys have not been conducted on the substrate of the river within the Action Area; however, grab samples were taken as part of the Wetland Delineation conducted for the EIS/Feasibility Study that did not exhibit the suitable substrates necessary for sturgeon spawning in the Pearl River. Critical habitat was designated up to the Ross Barnett dam on the Pearl River due to the potential of spawning sites being identified between Monicello, Mississippi, and the Ross Barnett Reservoir (F. Parauka, pers. comm. 2002); however, migration past the Jackson water supply weir to any potential spawning ground upstream towards the reservoir is impeded unless there is a high water event.

As discussed in section 4.2.1, the reach of the Pearl River in the Action Area can have fairly fast, deep flows during rain events but has shallow baseline flows and can exhibit shallow flows during certain parts of the year. Gulf sturgeon depend on flow regimes in the riverine environment for all life stages including migration, breeding site selection, courtship, egg fertilization, resting and staging, and for maintaining spawning sites in the suitable condition needed for egg attachment, sheltering, resting, and larval staging. Based on average flow rates from 1966 to 2013, this area of the river currently has high flows during the springtime with flows decreasing significantly during the summer (Table 2.1).

Water quality in the Action Area was discussed in section 4.2.1; however, a brief summary is provided here as well. In 2019, a water advisory was issued for the Pearl River in Jackson due to continued discharges of sanitary sewer overflows into the river. In the Action Area, there is a former creosote plant as well as two former landfills from which debris periodically washes into the river. Leachates from these landfills were found to contain heavy metals above the regulatory standards. In 2003, the EPA also found barium, cobalt, zinc, and other contaminates in the river in the Action Area.

5.3. Effects of the Action on Gulf Sturgeon Critical Habitat

This section analyzes the direct and indirect effects of the Action on critical habitat for Gulf sturgeon. Effects of the Action are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the Action may occur later in time and may include consequences occurring outside the immediate area involved in the Action (50 CFR §402.02). Our analyses are organized according to the description of the Action in section 2 of this BO.

5.3.1. Effects of Channel Excavation and Levee Relocation on Gulf Sturgeon Critical Habitat

The PBFs of flow regime, sediment quality, and migratory pathways would not be impacted by the construction of the channel excavation and levee relocation; therefore, this section will discuss the effects of the excavation and relocation on the PBFs of food and water quality.

As previously discussed in section 4.3.1, the channel excavation and levee relocation would occur during low water periods on the outer banks and an approximately 100-foot buffer along the riverbank would be maintained during excavation to retain some bank stability. Although the excavation and relocation would occur during low water periods, the Action Area would still be subject to increased sedimentation and turbidity should a heavy rainfall occur during construction and before vegetation cover could be reestablished. Increased turbidity when rainfall is the highest is a normal part of variations in turbidity following seasonal patterns of rainfall (Kishinh et al. 2006); however, the increase in turbidity would be additive to the normal turbidity surge due to the excess amount of loosened sediment during construction. Important contributors to the decline of aquatic assemblages are habitat degradation, sedimentation, and turbidity (Sawyer et al. 2004; Stewart and Swinford 1995; Henley et al. 2000). The increased turbidity and sedimentation would lead to impacts on water quality, which then leads to impacts on the prey base for juvenile sturgeon. See section 4.3.1 for more information on the effects of sedimentation and turbidity on the juvenile sturgeon food supply. These impacts on water quality would be temporary and would be reduced through erosion control measures.

5.3.2. Effects of Weir Construction and Impoundment on Gulf Sturgeon Critical Habitat

With the establishment of the 1,500-foot wide impoundment from the construction of the weir, changes to water velocity and water surface elevation in the Action Area would be anticipated. The weir has been designed to mimic the existing discharge of the river, and any changes in river discharge should be minimal once the pool area has been filled to the top of the weir. The impacts of flow are discussed in more detail in section 4.3.2.

Dams such as the proposed weir present an obstacle to sturgeon migration and are thought to be the main hindrance to Gulf sturgeon recovery in the Pearl River (Sulak et al. 2016). As a way to offset the effects of the weir on sturgeon migration, the construction of a fish passage channel is part of the proposed action. Kohl (2003) evaluated the opportunity to design a proposed bypass at the Poole's Bluff Sill to assist Gulf sturgeon migration north of the sill. That evaluation determined that a bypass channel could assist in sturgeon migration as long as the feature was designed to accommodate sturgeon swim speeds and other factors such as flow. Thus, if the fish passage channel were designed properly, it should provide for sturgeon migration past the weir structure. The impacts that the proposed weir and fish passage channel would have on sturgeon migration are discussed in detail in section 4.3.2.

Gulf sturgeon critical habitat in the Action Area is likely to experience reduced water quality during the construction of the weir and fish passage channel as a result of increased sedimentation and turbidity. As discussed in sections 5.3.2 and 4.3.2, this temporary effect would influence the macroinvertebrate community upon which juvenile sturgeon feed. Pools created by impoundments generally consist of fewer taxa of macroinvertebrates than free-flowing river reaches which tend to support a more diverse macroinvertebrate community (Santucci et al. 2005). However, Dean et al. (2002) found that while impounded areas lacked species diversity, the abundance of individuals was similar to that of free-flowing river reaches. Water quality was also modeled for the impoundment, and the results indicated that water quality would not significantly decline from the current condition. Accordingly, we could assume that the project would have minimal effects on the macroinvertebrate community because of the lack of changes to baseline water quality conditions. As discussed in section 5.2.1, suitable spawning substrate has not been indicated in this reach of the river; therefore, it is unlikely that spawning occurs in the area. However, sediment quality is important for more than just spawning. Sediment quality is also necessary for the macroinvertebrate food sources of juvenile sturgeon. The impacts to sediment quality on the macroinvertebrate community would be similar to impacts to water quality as described above.

As discussed in section 4.3.2, DO and temperature are other important water quality factors for sturgeon. As temperature increases, DO levels decrease which can affect the growth and respiration rates of juvenile sturgeon. Water quality modeling conducted for temperature and DO indicated post-project levels would have a slight but not significant difference from the pre-project levels. Thus, we can reasonably assume that while sturgeon may be stressed from any slightly lower levels, they would still continue to feed and grow.

5.3.3. Effects of Non-Federal Activities caused by the Federal Action on Gulf Sturgeon Critical Habitat

The relocation or retrofitting of existing infrastructure within the Action Area would lead to a reduction in sediment and water quality from the increased sedimentation and turbidity involved with implementing those actions. The increase in development adjacent to the improved channel could also lead to a reduction in water and sediment quality in the Action Area. Effects to water quality would be the same as mentioned above. The effects from decreased reduction in water quality are discussed in sections 4.3.2 and 5.3.3.

5.3.4 Summary of Effects of the Action on Gulf Sturgeon Critical Habitat

The Action Area encompasses a total of 19.37 miles of critical habitat that would be affected due to the Action. Thus, we estimate that approximately 3.9 percent of critical habitat Unit 1 and 1.1 percent of the total riverine critical habitat units would be impacted by the Action. Based on the best available data, the collective activities from the Action would affect the PBFs including food, flow regime, water quality, sediment quality, and migratory pathways, however, these impacts would either be temporary or offset by activities such as the construction of a fish passage for migratory purposes.

5.4. Cumulative Effects on Gulf Sturgeon Critical Habitat

For purposes of consultation under ESA §7, cumulative effects are those caused by future state, tribal, local, or private actions that are reasonably certain to occur in the Action Area. Future Federal actions that are unrelated to the proposed action are not considered, because they require separate consultation under §7 of the ESA. At this time, the Service is unaware of any future state, tribal, local, or private non-Federal actions planned or scheduled that would occur in the Action Area. Therefore, cumulative effects are not relevant to formulating our pinion for the Action.

5.5. Conclusion for Gulf Sturgeon Critical Habitat

In this section, we summarize and interpret the findings of the previous sections for Gulf Sturgeon critical habitat (status, baseline, effects, and cumulative effects) relative to the purpose of a BO under §7(a)(2) of the ESA, which is to determine whether a Federal action is likely to:

a) jeopardize the continued existence of species listed as endangered or threatened; or
b) result in the destruction or adverse modification of designated critical habitat.

"*Destruction or adverse modification*" means a direct or indirect alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species" (50 CFR §402.02).

The Action Area occurs at the northernmost extent of Critical Habitat Unit 1. As discussed in Section 4, the Action Area encompasses the Pearl River and its adjacent lands from the Ross Barnett dam south to 1.6 miles south of the weir structure. A total of 19.37 miles of critical habitat would be affected equaling approximately 3.9 percent of Unit 1 and 1.1 percent of the total riverine critical habitat units being impacted. (Please note that this assessment does not include the estuarine and marine units of critical habitat because none would be affected and because we are specifically addressing changes to the riverine portions of Gulf sturgeon critical habitat due to the PBFs being affected.) The PBFs impacted by this Action are food, flow regime, water quality, sediment quality, and migratory pathways.

Water and sediment quality go hand in hand when it comes to effects on food resources. The analyses of water and sediment quality impacts from implementing the Action indicate that impacts would be either temporary or insignificant, which infers that impacts to food sources for foraging sturgeon would be minimal. A reduction in water and sediment quality from sedimentation and turbidity from the indirect actions (e.g., relocation of and retrofitting existing infrastructure) would also be temporary, because water quality would return to similar conditions once such actions are completed. The modeling of water quality parameters, specifically temperature and DO, pre- and post-project does not indicate a significant difference in those parameters; thus, water quality in the Action Area would not be permanently degraded to such a degree that sturgeon would not be able to use the area.

The weir structure would impact the migratory pathway to sturgeon movement into this reach of the river. To offset the effects to sturgeon migration from the weir, a fish passage structure has been designed for just downstream of the weir. There is no documentation of sturgeon using fish passage structures, but studies show that certain designs would make migration through a fish passage more successful. Specifically, swim speed should be considered in the design of the fish passage feature in order to maintain sturgeon migration into the Action Area post-construction.

Our analysis indicates that while the Action would have negative effects to 3.9 percent of Critical Habitat Unit 1 and 1.1 percent of the riverine units as a whole, it is not likely to appreciably diminish ability of Unit 1 to provide the intended conservation value to the Gulf sturgeon and would not result in an adverse modification to Critical Habitat Unit 1.

6. RINGED MAP TURTLE

6.1. Status of the Ringed Map Turtle

This section summarizes best available data about the biology and current condition of the Ringed map turtle (*Graptemys oculifera*) throughout its range that are relevant to formulating an opinion about the Action. The Service published its decision to list Ringed map turtle as threatened on December 23, 1986 (51 FR 45907 45910). The most recent published 5-year review was completed August 17, 2010. A new 5-year review was requested to be initiated May 7, 2018 (83 FR 20092 20094).

6.1.1. Description of the Ringed Map Turtle

For a thorough description of the ringed map turtle see Jones & Selman (2009); all information in this section can be found in that description unless otherwise cited. The ringed map turtle is a small turtle. Each shield of its upper shell (carapace) has a yellow ring bordered inside and outside with dark olive-brown; its undershell (plastron) is yellow. 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. Males grow on average to 3.5 inches (89 millimeters) and females to 6 inches (156 millimeters) in plastron length.

6.1.2. Life History of the Ringed Map Turtle

The ringed map turtle's habitat is typically riverine with a moderate current and numerous basking structures. Using data from five studied populations in Mississippi, river conditions have been described as:

- width from 67 to 361 feet (20 to 110 meters);
- mean stream flow rates from 3,000 to 15,000 cfs; and
- river bottom composed of clay, sand or gravel.

This species has also been observed in oxbow lakes that are connected or disconnected from the main river system. It is assumed that turtles observed in disconnected lakes arrived due to flooding and remained or were isolated during construction of the levees. Individuals have been reported from the Ross Barnett Reservoir, although there is no evidence of a breeding population there or in any disconnected lakes (Selman 2018). Basking structures vary from deadwood to man-made structures (e.g., culverts, shopping carts, etc.). The turtles are found in rivers that must be wide enough to allow sun penetration for several hours. Turtles prefer basking sites which are partially submerged in areas with the deepest water and swiftest current. The occurrence of downed trees within the river has been strongly associated with the presence of *Graptemys* (Killebrew et al. 2002; Linderman 1997, 1998, 1999). However, ringed map turtles have also been found in areas that are predominately shallow with few deep areas (Selman and Smith 2017).

The preferred velocity of the ringed map turtle has not been determined; however, Killebrew et al. (2002) determined that the Cagles map turtle (*Graptemys caglei*) preferred velocities from 0.5 to 2.5 fps. Shealy (1976) stated that the Alabama map turtle (*Graptemys pulchar*) was found in velocities typically ranging from 0.9 fps to 2.7 fps. To aid in the impact determination the Service examined computer modeled without project velocities for that reach of the river where the stable Lakeland population is found; typically velocities ranged from 0.4 to 2.0 fps. Because those velocities are mean cross-sectional velocities the Service used that information and the Cagle's map turtle velocities to hypothesize that suitable velocities for the ringed map turtle would likely occur between 0.5 and 2.5 fps.

Nesting habitat consists of large, high sand bars adjacent to the river. Sandbars range in size from 430 square feet (40 square meters) to over 2.2 acres (8,900 square meters) and are generally composed of 39 percent open sand, 38 percent herbaceous vegetation, and 23 percent woody vegetation (Jones 2006). Nesting has also been reported to be attempted in shell road beds and mowed grassy areas adjacent to the river. Nesting occurs during daylight hours from mid-May through mid-July. Nest sites are usually located, on average, 59 feet (18 meters) from water and within 3.3 feet (1 meter) of vegetation, with an average canopy cover of approximately 37 percent.

The diet of the ringed map turtle consists primarily of insects (caddisflies, diptera, mayflies, and beetles) and mollusks. Some observational data have also pointed to carrion as a food source. Selman and Linderman (2018) postulated that ringed map turtles may also consume freshwater sponges as do other *Graptemys*. The presence of wood in diet samples of the ringed map turtle indicate that sponges and vegetative prey items (e.g., filamentous algae) may occur along with animal prey on deadwood substrate.

Jones (2006) found a minimum of approximately 60 percent of the females reproducing annually, but some females may skip a year between nesting. Nesting was found to only occur during daylight hours and primarily before noon. Nesting is initiated in May and ends in August with multiple (2 to 3) clutches per year being common (annual clutch frequency ranged from 0.96 to 1.42). Clutch size averaged approximately 3.6 eggs per nest. Final nesting attempts usually ended towards the end of July. Eggs incubate for approximately 64 days (Jones 2006) before pipping and then hatchlings emerge approximately 12 days after pipping (total time in the nest is approximately 76 days).

Mean annual survivorship estimates for males, females, and juveniles were 0.88, 0.93, and 0.69, respectively. Maximum longevity estimates were 48.8 years for males and 76.4 years for females. Average longevity estimates were 13.9 for females and 8.5 years for males. The sex ratio of captured turtles was male-biased before 2000 but unbiased after 2000. Time to maturity varies between male and female turtles. Males mature at about 4.6 years of age while females mature about 9.1 years of age (Jones 2017).

6.1.3. Numbers, Reproduction, and Distribution of the Ringed Map Turtle

The ringed map turtle is restricted to the main channels of the Pearl, Strong, and Bogue Chitto Rivers in Mississippi and Louisiana (Figure 6.1). It occurs in most reaches of the Pearl River from near the coastal salt water influence in St. Tammany Parish, Louisiana, upstream to Neshoba County, Mississippi. It only occupies the lower approximately 4.7 miles of the Strong River in Simpson County. In the Bogue Chitto River it is found upstream to Warnerton, Louisiana. Occupied river miles are estimated to be 488.5 miles.

Using 25 years of data at 5 sites along the Pearl River in Mississippi, Jones (2017) provides the most recent information on long-term trends for the ringed map turtle in the mid- and upper-Pearl River. While the population trend as a whole remained stable over the 25 years of the study, one site showed decline (Carthage), three sites showed the initial stages of decline (Ratliff Ferry, Monticello, Columbia), and one site (Lakeland) is relatively stable (Table 6.1).

In 2012, Landry conducted survey on the Pearl River near Bogalusa. Landry & Gregory (2010) conducted the most recent survey of the Bogue Chitto River following up on a 1999 survey of the same reach (Shively 1999). Between 6.51 to 114.7 turtles/kilometer (km) were estimated between the confluence of the river and Warnerton, Louisiana. Turtle concentrations were higher in the downstream reaches, potentially due to acclimation to human disturbance. Ringed map turtle numbers were down from the previous survey.

Recent surveys on the Pearl River below the Bogue Chitto River are limited. Dickerson and Reine (1996; summarized in Selman and Jones 2017) surveyed between Pools Bluff and Hwy 90 and found between 15.7 (Bogue Chitto Sill) to 1.4 (Pools Bluff) turtles/km. Along the East Pearl River at Stennis Western Maneuver Area, basking surveys conducted from 2012 to 2015. Abundance was estimated between 1.2 and 6.8 turtles/km (Buhlmann 2017). Over all, there are 12 relatively recent separate surveyed areas across the ringed map turtle range. These surveyed reaches represent 1.37 percent of the species' range, but there are river reaches longer than approximately 80 miles that have neither recent nor any survey information. The survey reports for six areas did not mention a trend in the abundance. Of the remaining six, one was declining, three were in the initial stages of decline, another one was declining but the stage of decline was not stated, and only one was stable.

The use of basking surveys to obtain a relatively good indication of the abundance level has been suggested by Jones and Hartfield (1998) and Killebrew et al. (2002). To determine the overall abundance the Service estimated the occupied river miles within the species' range based on literature. The U.S. Geological Survey's (USGS) stream reporter (txpub.usgs.gov) was used to determine river miles; adjustments to those mileages were done in ArcGIS using the National Hydrologic Database. The mean number of basking turtles observed for all surveyed reaches was extrapolated to the unsurveyed reaches to estimate a range wide abundance. The Service assumed an even distribution across the range; however, Killebrew et al. (2002) and Lechowicz (undated) found *Graptemys* were not always evenly distributed. The range in abundance displayed in Jones (2017) indicates an unequal distribution for the ringed map turtle; however, the Service could not find literature indicating a better method for determining *Graptemys* distribution and abundance. The Service used an average of all surveyed reaches to calculate an average abundance per river mile of the Pearl River (26.6 turtles/km) and used the average number of turtles from Landry and Gregory (2010) to calculate the abundance in the Bogue Chitto; the Service estimates approximately 17,916 turtles occur across the species' range (Table 6.1).

6.1.4. Conservation Needs of and Threats to the Ringed Map Turtle

Several threats were identified at the time of listing of the ringed map turtle (1986):

- habitat modification (desnagging, channelization, impoundment, and erosion),
- water quality degradation (pollution & siltation),
- over-utilization (collection for the pet trade and shooting of basking turtles for recreation);
- disturbance of nesting and basking (due to recreation and boating); and,
- The subsequent recovery plan (1988) identified predation as an additional threat.

At the time of listing, 21 percent of the ringed map turtle's range had been modified by channelization or impoundment and an additional 28 percent of that range had construction projects planned or authorized. This includes the Ross Barnett Reservoir and a channelized section within the Action Area. While many of the projects have not been constructed, and some are no longer under consideration, some are still authorized and may be initiated if funding becomes available. The ringed map turtle is not found within the approximately 16-mile-long Ross Barnett Reservoir which creates a barrier to turtle movement, though a small remnant population is found in Pelahatchie Creek near the dam. It has been stated that operations of the reservoir have created downstream impacts to habitat including channel filling and widening due to collapse of waterlogged banks from sudden water releases to maintain pool elevations (Selman and Jones 2017) and channel instability resulting from captured sediment in the Ross Barnett Reservoir (Hasse 2006; Kennedy and Hasse 2009; Tipton et al. 2004). Killebrew et al. (2002) stated that populations of Cagle's map turtle (*Graptemys caglei*) found downstream of a dam were decreased due to rapid changes in the water level associated with dam releases. Those dam releases were implicated in the flooding of nests and reduced food availability. Richards and Seigle (no date) stated that fluctuating water levels downstream of a dam altered habitats, reduced turtle movements, and resulted in loss of basking habitat for the northern map turtle (*Graptemys geographica*).

The recovery plan recognized that to reduce the threat of habitat modification, habitat protection was needed. Criteria 1 of the plan identified that protection of a total of 150 miles of the turtle's habitat in two reaches of the Pearl River was needed to delist the species. The reaches must be on opposite ends of the Ross Barnett Reservoir, and there must be a minimum of 30 miles in either reach. Currently there is only one protected reach north of the Ross Barnett Reservoir, an approximately 11.8–mile-long ringed map turtle sanctuary. Just south of the reservoir one of Mississippi Department of Transportation's mitigation banks protects 21,491 linear feet (approximately 4 miles) of the east bank of the Pearl River. Approximately 73 miles of at least one bank in the lower Pearl River is within state or federally protected and managed lands, but this area has some of the lowest population densities. Thus, additional protected areas are needed to meet this recovery goal. However, placing lands within a protected status may not be sufficient to preclude the decline of a turtle species (Browne and Hecnar 2007); additional management actions may also be required.

Agricultural, municipal, and industrial effluents may have historically impaired water quality in the lower Pearl River (McCoy and Vogt 1980). Direct effects of water quality on ringed map turtles has not been researched, but negative effects to their primary food sources has (Stewart et al. 2005). Decreases in other *Graptemys* species have been attributed to reduced water quality downstream of development (Killebrew et al. 2002). Selman and Jones (2017) cited studies that pointed to the decrease or loss of *Graptemys* species due to poor water quality in the Pearl River; recovery of those Pearl River populations due to improved water quality was also noted.

Predation of nests by raccoons, armadillos, and fish crows is well documented with most nests being predated within 14 days (Jones 2006). Predator numbers have increased and may be subsidized by humans which could have an impact on recruitment (Bulhmann 2017; Jones 2006). Jones and Selman (2009) suggested that those predators could have a significant impact to recruitment in the future. A recent increase in American alligators (*Alligator mississippiensis*) was also postulated to have possibly resulted in a decline in adult males and juveniles (Jones 2017). Predation is estimated to destroy approximately 86 percent of nests, and invertebrates (i.e., ants and fly larvae) kill an additional 24 percent of fertilized eggs within nests.

The impact of human disturbance, primarily recreating (e.g., camping, picnicking, boating) to nesting turtles and/or nests has been pointed to as another source of decline in the population (Jones 2006; Jones 2017; Selman and Jones 2017). Horne et al., (2003) found that even their observation blind reduced *Graptemys flavimaculata* nesting attempts by three times more than without that disturbance. Direct mortality associated with recreational and commercial fishing and recreational boating has been identified as another impact to *Graptemys* populations (Bluté et al. 2010; Selman et al. 2013; Smith et al. 2018). Jones (2017) expressed a concern about those same activities impacting the ringed map turtle. Blute et al., (2010) found that impacts to the northern map turtle (*Graptemys geographica*) from boat strike could lead to an increased risk of localized extinction. The potential for reduced vigor because of disturbed basking has been found in other *Graptemys* populations as well as the ringed map turtle (Heppard and Buchholz

2018; Selman and Qualls 2011; Selman et al., 2013). Based on basking surveys it is apparent that *Graptemys* species including the ringed map turtle may habituate to humans, the amount of time required for such habituation is not known and there is some uncertainty as to the degree of habituation that will occur. (Jones and Hartfield 1995; Landry and Gregory 2010; Lechowicz 2013; Selman and Jones 2017, Selman and Qualls 2011; Selman et al., 2013).

Listing of the ringed map turtle as federally threatened may have reduced impacts of the pet trade that trade is still apparently operating within the Pearl River Basin (Jones 2017; Selman and Jones 2017).

The most recent 5-year review (USFWS 2010) confirmed that all of the threats continue.

6.1.5. Tables and Figures for Status of the Ringed Map Turtle

See following pages.

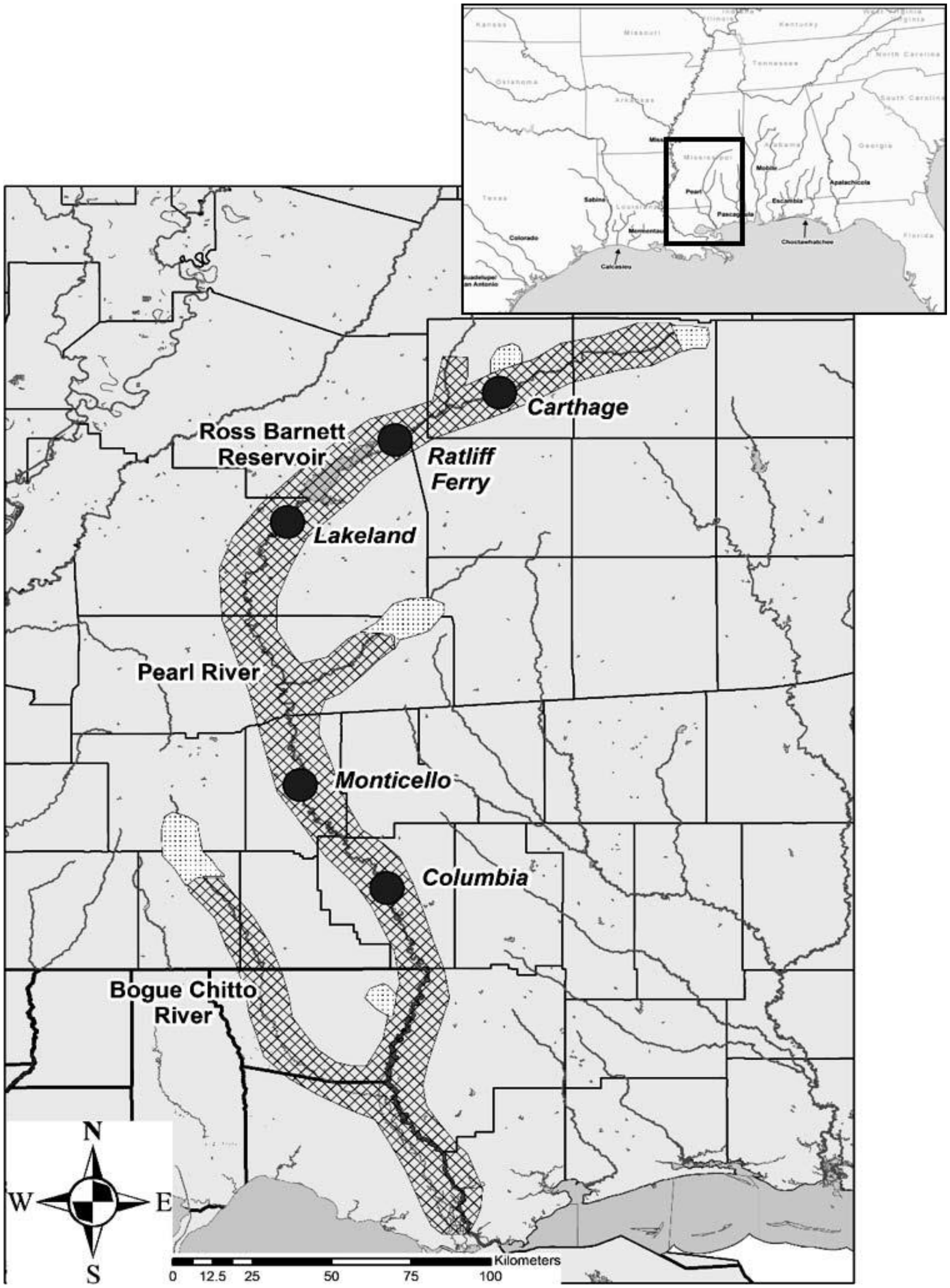


FIGURE. 6.1. The geographic location of the Pearl River in the southeastern United States (top inset) and map of sample sites in central Mississippi (bottom). Cross-hatching represents areas where *Graptemys oculifera* and *Graptemys pearlensis* co-occur; whereas stippling represents upstream areas only occupied by *G. pearlensis* (based on maps by Lindeman 2013) and new records of Lindeman (2014a, b). Taken from Selman and Jones 2017.

Table 6.1. Abundance estimates based on basking survyes1 and percent of species range.

Source	Location	Variation in number of turtles per kilometer (km)	Mean number of Turtles Observed	Total Number of Turtles Observed	Length of survey (km)	Turtles per km	Turtle Abundance (length of survey x turtles per km)	% of occupied river each survey area represents with channelized areas combined[3]	Surveyed reaches estimated percentage of abundance based on average abundance applied to non-surveyed reaches (26.6 turtles/km)[4]
Jones 2017	Pear River: Carthage	SD± 15.5	62		4.8	13	62.4	0.6	0.3
Jones 2017	Pearl River: Ratliff Ferry	SD± 51.1	188		3.2	59	188.8	0.4	1.1
Selman 2018	Pearl River: Jackson Reach S1[1]	173-389; SD±98	279.5		5.3	52.5	278.3	0.7	1.6
Selman 2018	**Pearl River: Jackson Reach S2**	**149-295; SD±63**	**220.6**		**5.3**	**41.5**	**220.0**		
Selman 2018	**Pearl River: Jackson Reach S3**	**42-77; SD±15**	**62.6**		**5.3**	**11.7**	**62.0**	**2.0**	**2.2**
Selman 2018	**Pearl River: Jackson Reach S4**	**59-177; SD±49**	**109.6**		**5.3**	**20.6**	**109.2**		
Selman 2018	Pearl River: Jackson Reach 5	166-291;SD±47	240.4		5.3	45.2	239.6	0.7	1.3
Jones 2017	Pearl River: Monticello	SD± 33.5	96		4.8	20	96.0	0.6	0.5

Table 6.1. Abundance estimates based on basking survyes1 and percent of species range – continued.									
Source	Location	Variation in number of turtles per kilometer (km)	Mean number of Turtles Observed	Total Number of Turtles Observed	Length of survey (km)	Turtles per km	Turtle Abundance (length of survey x turtles per km)	% of occupied river each survey area represents with channelized areas combined[3]	Surveyed reaches estimated percentage of abundance based on average abundance applied to non-surveyed reaches (26.6 turtles/km)[4]
Jones 2017	Pearl River: Columbia	SD± 17.7	62		4.8	13	62.4	0.6	0.3
Landry and Gregory 2010	Bogue Chitto River	6.51 – 114.7		208	43.9	4.7	208.0	5.6	1.2
Landry 2012	Pearl River: West Pearl			121	10	12.1	121.0	1.3	0.7
Bulhammn 2017[2]	Pearl River: East Pearl and Mike's River			43	10	4.3	43.0	1.3	0.2
Total					108	26.6	1690.6	13.7	

[1]Basking surveys are used because not all surveys included trapping or mark/recapture thus to assess project impacts to the species range wide the most consistent/predominant method of surveying was used.

[1]This reach overlaps Jones 2017 Lakeland population, because Selman's data is more recent, Jones 2017 Lakeland population information is not included in the analysis.

[2] Mean for the three year sampling period was used because individual years included unidentified turtles.

[3] To determine the total length of river occupied by ringed map turtle the Service started at Hwy 15 Pearl River crossing south of Burnside subtracted the Ross Barnett Reservoir (16 miles) and the river mileage below Interstate 10 (14 miles); the East Pearl path was measured below the river bifurcation (total distance 602.4 km [380.4 miles]). The Bogue Chitto was measured starting at the confluence of McGee Creek in Mississippi, down the West Pearl to Interstate 10 (total distance 167.4 km [104 miles]). The lower 7.6 km (4.7 miles) of the Strong River. All miles total equals an estimated 786 km (488.5 miles).

[4] 26.6 turtles per km was multiplied by the potential total occupied river miles of the Pearl and Strong River (610 km) minus the Pearl River sampled reaches (64.1 km). This produces an estimate (16,226) of the overall abundance of turtles within the Pearl River range outside of the sampled reaches. The Bogue Chitto total occupied habitat was determined the same way but the turtles per km for that river were used (i.e., 167.4 km - 43.9 km = 123.5 km x 4.7 turtles/km = 580.5 turtles). Within the sampled reaches an abundance of approximately 1690.2 turtles and range wide is estimated at 17,916.

6.2. Environmental Baseline for the Ringed Map Turtle

This section is an analysis of the effects of past and ongoing human and natural factors leading to the current status of the Ringed Map Turtle, its habitat, and ecosystem within the Action Area. The environmental baseline refers to the condition of the listed species or its designated critical habitat in the Action Area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the Action Area, the anticipated impacts of all proposed Federal projects in the Action Area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 CFR §402.02).

6.2.1. Action Area Numbers, Reproduction, and Distribution of the Ringed Map Turtle

Recent surveys by Selman (2018) provide a current estimate of the number and status of ringed map turtles in the Action Area (Table 6.1 above). Ringed map turtles were also observed in oxbow lakes and sloughs adjacent to the Pearl River within the Action Area; however, not all oxbow and slough habitat will be altered by the proposed impoundments. Only a portion of Crystal Lake will be impacted by proposed levee realignment (set-back) and impoundment. Ringed map turtles are found throughout all reaches of the Pearl River within the Action Area, with lower numbers in the channelized sections of the River (just south of RM 293 to approximately RM 287). Approximately 40 percent of the proposed excavation area has little or no riparian habitat and little to no natural basking and feeding habitat, especially within the channelized portion. Selman (2018) found a greater concentration of turtles within forested riparian sites along this portion of the river. He also documented nest sites, turtle nesting crawls, and juvenile turtles all indicative of successful recruitment occurring in all stretches of the Action Area, including the area with reduced riparian habitat. A greater abundance of juveniles (10 to 20 percent) was found within the northern channelized section than in other sites outside of the Action Area. Selman (2018) postulated that the increased juvenile production may result from the use of narrower sandbanks along the channelized sections as opposed to sand bars, thus reducing predation success. Approximately 31.4 acres of accretion (e.g., sand bars, sand banks) were determined by the FCDCD to exist within the Action Area based on 2010 National Agriculture Imagery Program color photography; this acreage was spread over approximately 20 sites throughout the Action Area. Selman (2018) documented 20 sandbars within the project area and noted 102 potential nesting crawls. Of the 20 sand bars, 11 were not surveyed but two of those not surveyed were noted as having crawls but the number of crawls were not counted. Two surveyed sand bars had no nests or crawls.

Based on basking survey data, the Action Area represents 2 percent of the turtle's range having approximately 2 percent of the turtle's range wide abundance (Table 6.1 above). Jones (2006) used nesting survey data from upstream of the Action Area to develop a relationship between sandbar size and number of nests. Based on that relationship the approximate number of turtle nests found on the 31.4 acres of sandbars within the excavated area was calculated to be 1,177. With each nest having approximately 4 eggs per nest (rounded up from 3.6) this corresponds to approximately 4,326 eggs within the excavated area. However, once the 86 percent predation rate of nests and the 24 percent predation rate of eggs by insects are applied to the number of eggs only approximately 451 eggs are likely to hatch.

Not included in the above abundance estimate are the small isolated populations at Cypress, Crystal, and East and West Maye's Lakes within the project area. There has been no evidence of these populations reproducing (Selman 2018). Turtles at Crystal Lake were isolated from the river following levee construction. Due to the lack of riverine created habitat, especially nesting habitat, these populations are expected to eventually disappear. Selman (2018) counted 11 and 9 ringed map turtles at Cypress and Crystal Lakes, respectively. East and West Maye's Lakes were found to have 24 and 4 turtles, respectively; however, unlike Cypress Lake, the other lakes connect to the river during large flood events. Selman (2018) believed the population in both Mayes Lakes were supported by immigration only but were not viable. There are no construction activities proposed in the immediate vicinity of both Mayes Lakes and the adjacent Cypress Lake. Other ringed map turtle studies have typically not surveyed oxbows or lakes within the floodplain, though their presence was noted in downstream lakes.

Selman (2018) used basking density surveys along with basking frequency data from two *Graptemys* species found in the Pascagoula River to estimate population size within the Action Area (Selman and Qualls 2011; Selman and Lindeman 2015). Selman (2018) used correction factors of 20 and 30 percent of the basking population observed to estimate the potential range of turtles missed by such surveys. Killebrew et al. (2002) used a level of conspicuousness (between 33 and 36 percent) to estimate undetected turtles from basking surveys to predict population levels. The Service used the mid-point between Selman's ranges (i.e., 25 percent) as a reasonable method to estimate potential numbers in the Action Area. The Service also used survey results from Selman (2018) to determine the number of turtles within the channelized area and upstream and downstream of that area to which we applied the correction factor. Based on those calculations, the Service estimated that 2,196 turtles potentially exist in the area that will be inundated by the project. Upstream and downstream of the project area, we estimate approximately 1,556 and 1,164 turtles, respectively (2,720 total) with the later number representing the Lakeland population found north of the excavated area. In addition, we estimate that approximately 192 ringed map turtles inhabit Crystal, Cypress, and East and West Mayes Lake based on the 25 percent correction factor. In summary, we estimate a total of approximately 5,108 turtles occur in the Action Area. The estimated number of turtles includes juveniles as these are not separated in our analysis below.

Selman (2018) used information from two *Graptemys* species to develop the potential number of turtles in the Action Area. The use of surrogate species is common in conservation biology, particularly when implementing the ESA where needed data may not be available or is difficult to collect. Selman's use of a "correction factor" to determine population size within the project area is based off the peer-reviewed Selman and Qualls (2011) basking behavior study of an ecologically similar species (*Graptemys flavamaculata*, Yellow-blotched map turtle) within the Pascagoula River. This species is as equally imperiled as the ringed map turtle and suffers from similar threats. When lacking actual data for a species, we will use the best available information often from a surrogate species (Murphy & Weiland 2014; Caro 2010); Service policy on using surrogate species can be found in Final Rule 80 FR 90 26832-26845. Throughout this BO the Service has relied upon existing information about the ringed map turtle as much as possible; however, when information is deficient or absent the Service first examined literature regarding other *Graptemys* species, and then other aquatic turtle species to provide the best possible assessment of impacts to the subject species and its habitat.

6.2.2. Action Area Conservation Needs of and Threats to the Ringed Map Turtle

The current status of ringed map turtles in the Action Area has been heavily influenced by previous flood control actions and urbanization. Portions of the Pearl River within the Action Area have been channelized, desnagged, and contain a cleared floodway where woody vegetation is controlled via herbicide and/or mowing. These actions have reduced the amount of habitat available for this species, including reductions in basking material, potential foraging areas, and nesting sandbars. Relatively few deep areas are also found within this section. Degraded water quality through nutrient and pollution input through this urbanized section of the Pearl River may also be impacting the ringed map turtle populations. Even with these impediments the ringed map turtle manages to persist within the Action Area. Finally, the construction of the Ross Barnett Reservoir just north of the Action Area has resulted in a barrier to ringed map turtle migration from and into the Action Area. The significantly decreased water velocity within the reservoir, the lack of basking material, nesting habitat and increased development and recreational activities has resulted in the elimination of a viable population of ringed map turtles for the length of the reservoir (approximately 16 miles of the Pearl River, i.e., RM 302 to approximately RM 328). An isolated non-reproducing population is found in the Pelahatchie Creek area just north of the dam in the reservoir.

The Action Area contains one of the reaches selected in the 1988 Recovery Plan for long term population monitoring because of its perceived low population (Stewart 1988). This population, referred to as the Lakeland population, is 3 miles long and is found between the Ross Barnett Reservoir and Lakeland Drive (northern portion of the Action Area). The Service's most recent five-year status report states that the population at this location represents the healthiest population south of the Ross Barnett Reservoir. Approximately 30 percent of river within the Lakeland population area will be directly impacted by the project. Selman and Jones (2017) concluded that the Lakeland population is the only stable population they surveyed. There has been no long-term monitoring of the population south of Lakeland drive within the Action Area. Selman's recent surveys (2017, 2018) were the first efforts to document population status within this area.

The Ratliff Ferry population and populations to the north became isolated from populations south of the Ross Barnett Reservoir with the construction of that reservoir in 1960 (17 years short of the estimated longevity of a female). The ringed map turtle populations north of the reservoir are beginning to experience a decline. Predation and disturbance of nesting areas are believed to possibly be the greatest factors causing the decline along with sedimentation in the upper portion of its range (Jones 2017).

After studying the Ratliff Ferry and Lakeland populations, Heppard and Buchholz (2019) suggested that increases in boat traffic can be mitigated to some extent by providing greater basking perch abundance and by reducing boat speed and the interwake interval of passing boats. They recommended that no wake zones be placed around areas set aside for ringed mapped turtle conservation and that basking refugia be established by restricting boater access. Turtles basked for longer times in no wake zones. The proposed measures would be done to improve the health, survival and reproduction of the ringed mapped turtle and reduce the likelihood of boats striking adults. For the Lakeland and the three other populations studied in the northern part of the range, Selman and Jones (2017) attributed some of the population declines to direct mortality from boat strikes.

6.3. Effects of the Action on the Ringed Map Turtle

This section analyzes the direct and indirect effects of the Action on the Ringed Map Turtle. Effects of the Action are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the Action may occur later in time and may include consequences occurring outside the immediate area involved in the Action (50 CFR §402.02). Our analyses are organized according to the description of the Action in section 2 of this BO.

6.3.1. Effects of channel excavation and levee relocation on the Ringed Map Turtle

To decrease sedimentation from the construction site and allow most excavation to occur in a dry environment, excavation of areas away from the river bank would occur first. This would leave the riverbank and an additional adjacent area separating the river from the excavation area undisturbed. During the final construction phase the buffer (i.e., river bank area) would be removed and then the area river would be closed and the area would flood. Prior to that, the buffer area would reduce the likelihood of disturbing basking turtles or turtles attempting to nest and would reduce the potential of having nesting sites located within ongoing work areas. Therefore, we anticipate a very small percentage of turtles will be killed due to ground disturbance activities away from the river

Disturbance from excavating 25 million cubic yards of material from approximately 1,901 acres within and adjacent to the river over approximately two years could result in death of individuals if they are unable to flee the construction work area. Most of the top bank of the river will be disturbed through the direct removal of vegetation, sand and dirt as well as through other associated ground disturbing activities such as stockpiling dirt, machinery egress and ingress, etc. Aquatic turtle research that focused on disturbances associated with construction found that aquatic turtles within a construction area would move up or downstream from the construction activity (Chen and Leu 2009; Plummer and Mills 2008). Therefore, it is reasonable to assume that many turtles currently found in the proposed impounded area will slowly move away from construction activities. As construction progresses upstream from the weir location it is assumed that most turtles will migrate upstream and will encounter the Lakeland population where the river will not be directly altered. At the downstream end of the project some turtles are likely to move downstream encountering turtles south of the weirs location. All turtles in the construction area (estimated at 2,196) are expected to be disturbed in some form of alteration of normal feeding, basking and nesting activities while channel excavation activities are taking place and they are displaced from the construction site.

A modest decline in the softshell turtle (*Apalone spinifera*) population in a small stream was noted by Plummer et al., (2008) following the excavation of that area. That population recovered within four years (Plummer and Mill 2008). They postulated that having areas (up or down stream) to escape construction activities was important in avoiding a population impact from construction. Eskew et al., (2010) also found pre-impact population levels four years following disturbance to ponds inhabited by painted turtles (*Chrysemys pictato*) however, they did cite literature that pointed to potential long term declines following similar disturbance. Review of information in Chen and Leu (2009) indicates a population decrease of approximately 14 percent following excavation and concrete lining. Therefore, we believe that construction activities could result in the death of approximately 14 percent of the turtles (281 turtles or 0.4 percent of the population) within the channelized area as a result of construction activities. If excavation along the river occurs during the fall when turtles are less active the ability of turtles to escape may be reduced resulting in a slightly higher number of turtles being killed, regardless, the Service does not anticipate that a large number of turtles will be killed by excavation activities.

To offset the loss of 31.4 acres of nesting habitat due to excavation and submergence an equal or greater number of sandbars would be recreated in areas identified as having velocities suitable for ringed map turtles during higher flow periods. *Graptemys* and other aquatic turtles have been found to successfully use artificially created nesting habitat (Dobie 1992; Goodwin 2002; Patterson et al., 2013; Seigel et al., 2016). The greatest problem with created nesting habitat is the high predation rate and disturbance by humans. Reducing either or both of these factors would increase nesting success offsetting some project impacts.

The project would also include the creation of islands from approximately RM 289.5 to RM 292.0 in addition to previously mentioned sandbars. These areas would have public access restrictions, placement of snags and no wake zones. The proposed islands and sandbars within the new impoundment would include in their design nesting and basking habitat features for turtles that remain in the excavated portion of the river. Typically, sandy areas within the area encourage beach use by recreational boaters. The FCDCD has indicated that they will have law enforcement authority to restrict access to conservation features and will also use signage to prevent use of sandbars, islands, and sandbanks by the public. Without adequate enforcement of no-human disturbance and vegetative maintenance these features would be ineffective (Godwin 2002). The low nest survival rate due to predation may further reduce the success of created nesting habitat on islands therefore, monitoring of predation rates would be undertaken to determine the need to reduce land based predators (e.g., raccoons, armadillos) and improve hatchling success. To help ensure the nesting and basking areas provided are suitable habitat, areas with higher modeled velocities within the improved channel were identified and targeted for the creation of those habitats. Basking habitat would be recreated through the placement of trees, root wads and crowns adjacent to the sandbars. No-wake zones would be established to reduce disturbance to basking turtles and shelfing of nesting sites. Because the proposed location of some of the sandbars are in areas that would expose turtles to disturbances, such as road noise, the degree of success cannot be fully estimated however currently ringed map turtles are found near highway crossings in the area (Selman and Smith 2017). Locating sand bars adjacent to highway ROWs could reduce the potential recreational boat usage of such sites and adjacent basking habitat and aid in the enforcement of no public access. There is insufficient information for us to estimate the positive benefits of no wake zones on nesting habitat, turtle health and reduced direct mortality from boat strikes, even though literature recommends this measure to reduce all of those factors. Constructing approximately 20 acres of sand bars on the islands and implementation of predator controls to limit predation to 73 percent produces an estimated 357 additional hatchlings to the population each year.

During the year that the river banks would be excavated, sand bars in the area would be surveyed every two day at the start of the nesting season. Any nests found would be relocated north of the excavated area (specific locations would be coordinated with the Service and MSDFWP). Relocated nests would have predator guards placed over them and would be monitored for nesting success. Typically, turtle nests with predator guards have a higher chance of hatching with the percent of successful nests varying from 78 to 100 percent (Horne et al., 2003; Jones 2006). It is estimated that the 1,177 potential nests on the 31.4 acres of sand bar in the excavation area could have approximately 4,236 eggs (3.6 eggs per nest). If approximately half of those nest are found prior to predation and are successfully transferred approximately 2,118 eggs could potentially hatch. Predation by insects could further reduce that number to 1,609 hatchlings. This represents an increase above the determined predation rates by Jones (2006) that estimates those nests would produce only about 451 hatchlings. Selman (2018) postulated that the higher number of juveniles found in the channelized section that will be excavated results from a higher hatching success rate. The success of relocated nests has been documented (Burke et al., 1998; Kornaraki 2006; McElroy 2006; Wyneken 1988) with higher nesting success rates at times resulting from the relocation to better nesting sites (e.g., farther from possible flooding, etc.). Mortality resulting from moving eggs has been documented but the reported best times during incubation to move eggs has yet to be defined (Ahles 2009; Bonach et al., 2003; McElroy 2006).

Approximately 10 miles of river bank would also be preserved and protected through either fee-title purchase or restrictive easements assigned to the land. Such restrictions would prevent the development of habitat adjacent to river thus providing a barrier against disturbance and loss of habitat. This action and implementation of no public access and no wake zones would aid in ensuring greater nesting success and an increase in less disturbed basking periods which can help maintain the health of the turtles (Heppard and Buchholz 2019). Based on information presented in Jones (2006) and Selman (2018) we determined that there are on average approximately 2 sand bars per river kilometer. If 5 miles of both sides of the river are purchased (total of 10 miles of riverbank) then approximately 13 sand bars would be protected. Jones (2006) documented the size of 11 sand bars in approximately 4 river kilometers. Sand bars varied in size from 38 to 9085 square meters and averaged 2,486 square meters. If public access conditions are enforced we estimate that the disturbance to nesting attempts measured by Horne et al. (2003) might be reduced by half. This would result in one average sized sand bar producing an additional 8 hatchlings per year (based on Jones 2006 equation relating sand bar size to number of nests multiplied by the average clutch size). If protection could be applied to 13 sand bars an additional 99 hatchlings would be produced each year based on all sand bars being average in size. Applying the same methodology to the sand bars presented in Jones 2006 it is estimated that approximately 1,226 more hatchlings could be produced per year.

The influence of increased hatchlings survival on the perpetuation of a population has been investigated; hatchling and juvenile mortality is often high enough that reduction of adult mortality is believed to be a better option to sustain the species. However, in populations with little recruitment increasing the survival of hatchlings (Knoerr 2018) and adults (Heppell et al. 1996; Spencer 2017) is viewed as being a better means to ensure survival.

Elimination of basking habitat, disturbance during basking by construction activities and the reduction of food sources due to increased turbidity and removal of structure can result in the decreased health of turtles (Chen and Lue 2009; Heppard and Buchholz 2019). All turtles in the Action Area (2,196) would likely experience these effects especially during the final construction phase. As turtles move from the construction area into areas already inhabited, the potential for crowding with concurrent increased stress and competition for food and habitat could affect their health, survival and reproduction (Chen and Lue 2009). These effects would be felt by all turtles in the Action Area (2,196) as well as those in the Lakeland population (1,556) and those downstream of the weir (1,164). Currently, of the 9.5 miles of river bank in the excavated area, over approximately 4 miles (approximately 40%) have no or limited wooded bank line, thus a portion of the population within the excavated area is persisting in an area with little riparian buffer. The placement and maintenance of basking habitat would offset the loss off existing basking habitat.

The excavated material will be used to upgrade existing levees in the Action Area as well as used to create new levees and 971 acres of elevated fill for future economic development and parks. This will result in the removal of any forested riparian habitat which is the main source of basking and feeding habitat and escape cover used by *Graptemys* (Lechowicz 2013; Lindeman 1997; Lindeman 1998; Lindeman 1999; Killebrew et al., 2002). Reforestation of the lake perimeter is not planned so naturally occurring basking and feeding habitat will largely be eliminated and not replaced. The loss of this habitat would be reflected in the decreased health, survival and reproduction; these adverse effects would be felt by all turtles that remain or return to the channelized area following construction. However, these adverse effects should not result in the lethal take of any turtle and the project includes placement and maintenance of basking and foraging material at the created sandbars thus reducing the impacts from the loss of those areas that have this habitat.

Relocation of the levee near Cypress Lake is expected to disturb those turtles living in that lake, however, trapping and relocation of an estimated 20 of the 36 turtles back into the Pearl River in the northern part of the Lakeland area is planned prior to construction to reduce the potential for direct mortality as these turtles cannot move up or downstream to avoid construction activities.. We expect the remaining turtles to be able to avoid the construction area and not be directly harmed by the activity.

Relocation of turtles, especially aquatic turtles has had varied success (Attum et al., 2013; Attum and Cutshall 2015; Bogossian 2010; Sealy 1976). Soft releases (i.e., including a period of acclimation prior to full release) of turtles has reduce the movement of turtles away from the point of release (Attum and Cutshall 2015); some increased success has also been noted in the relocation events that occur prior to estivation and with greater distances moved. Differential movement between the sexes of mature adults has been noted but relocated juveniles tend to move less than relocated adults. Time till return has taken up to three years (Sealy 1976). Because the relocation site would be separated from the capture site by a levee, the return to that site is improbable, thus increasing the chance of successful relocation, but dispersal from the relocation area may occur. The potential to capture and release individuals from areas where they would never contribute to the population and possibly be affected by construction and relocate them so that they may contribute to the population is the goal of this action. Tracking of the released turtles would aid in the knowledge needed to ensure the continued survival of the species. It is estimated that no more than 20 turtles will be captured and translocated. While a positive conservation action this would result in the harassment of approximately 20 turtles.

An adaptive management and monitoring plan will be developed in conjunction with the Service and the Mississippi Department of Wildlife, Fisheries and Parks (MDWFP) which would provide ongoing monitoring, long-term management, and habitat protection benefits for the listed turtle. Based on the number of turtles handled and/or observed by Jones (2017) we anticipate up to 1,600 turtles over 15 years would be taken in the form of harassment due to being trapped, tagged, data collected, tracked, observed, and monitored for population and movement studies.

6.3.2. Effects of Weir Construction and Impoundment on the Ringed Map Turtle

The establishment of a 1,500-acre impoundment from weir construction will result in changes in the velocity and water surface elevation within the project area. Because the weir has been designed to match the current discharge of the river there should not be a significant change in discharge once flows begin overtopping the weir.

The lake conditions of the Ross Barnett Reservoir has precluded the ringed map turtle from persisting once the reservoir was filled. Killebrew et al., (2002) found Cagles map turtle was absent from five impoundments and attributed that absence to the lack of river type habitat including shoreline for nesting (including sandbars), shoreline vegetation for food and shelter (fallen trees or undercut banks exposing roots), and basking structure. Increase turtle abundance in small riverine lakes was attributed to the relatively unaltered shoreline, lack of development along the shoreline (any development was not close to the shoreline), and the small size of the lakes (a few hundred yards in length). Lakes small enough to still maintain lotic conditions were observed to have a greater abundance of turtles if they also possessed the previously mentioned habitat characteristics (Killebrew 2002). A decrease in Cagles map turtle populations occurred after repairs to a dam that was no longer retaining flows but was followed by an eventual increase once sandbars, riparian habitat, and snag habitat returned. However, if these habitat features did not return and/or if shoreline development occurred the turtle populations did not fully recover or were extirpated. Linderman (1998) stated that habitat characteristics, (deadwood and current) and shoreline development could explain the difference in *Graptemys* abundance in reservoirs. Sealy (1976) stated that the Alabama map turtle (*Graptemys pluchra*) could persist within a lake type environment but stated its degree of success in a lentic versus a lotic habitat has not been determined. Selman and Qualls (2009) did not observe any *Graptemys* in non-flowing lake like conditions created by gravel mines in the Pascagoula River. Selmans's (2018) survey of lakes within the Action Area determined that turtles were present but the populations were predominated by males and only one juvenile was observed. He characterized both Mayes Lakes as being ecological sinks with their populations being supported only by immigration and that of Crystal Lake as not having a long-term viability. Killebrew et al., (2002) found that Cagle's map turtle would be found between approximately 0.6 and 2.6 fps with an optimum velocity around 2.5 fps. Examination of modeled mean cross sectional velocities estimated at an average of approximately every 1,100 feet for the river miles where the Lakeland population is found indicates that the turtle is found in velocities between 0.4 and 2.3 fps. We hypothesize that this range represents the suitable velocities for the ringed map turtle. Because those velocities are mean cross-sectional velocities the actual suitable velocities may vary from those values, however, since all velocities for the project are mean cross-sectional values their application to the impact assessment is appropriate.

Flows of 20,000 cfs with the project constructed would experience velocities within the 0.4 to 2.3 fps range over approximately 83 percent of the range where they would be experienced without the project. At 40,000 cfs there would be an increase in the area experiencing those same velocities. However, once discharges decrease below 10,000 cfs the improved channel's velocities would significantly decrease (<0.4 fps) and lake like conditions would occur. Average monthly flows exceeding 10,000 cfs occur less than 13 percent of the time with that velocity rarely being exceeded from June through November or about half the year (Table 6.3). While this is the normal discharge pattern, the improved channel would experience average cross-sectional velocities that would not be within 0.4 to 2.3 fps during that time. At 10,000 cfs with the project constructed suitable velocities would be found in approximately 92.7 percent of the channel that normally would have those velocities. As discharges decrease the amount of area having suitable velocities would also decline; at 1,000, and 2,000 cfs there would no longer be any area having suitable velocities when prior to the project approximately 87 percent of the area would have had suitable velocities. At 5,000 cfs with the project constructed there would only be approximately 6 percent of the area within the estimated suitable velocities. Mean monthly velocities in the 1,000 cfs range typically occur from July through October. Velocities associated with those conditions will be similar to conditions found at the Ross Barnett Reservoir, where generalist turtle species such as the red-eared slider, common musk turtle, and common snapping turtle increased while specialist riverine turtle species such as the ringed map turtle decreased.

However, between RM 293 and 294 (approximately 0.2 percent of the species range) there would be a significant increase in velocities (>5 fps) that would make these portions of the river less favorable for the *Graptemys* resulting in an additional loss of suitable habitat during normal flow conditions (Killebrew et al., 2002). At higher discharge events (equal to or greater than a five year event) there would be a decrease in velocities which would be allow this area to temporally provide habitat to the turtle on an infrequent basis.

While velocity is not the only habitat factor determining *Graptemys* use of lake like areas, it has been identified as an important one. Its importance is often linked to the need for erosional forces that create tree falls and sandbars. While almost all of the channelized area would not experience those type of velocities at discharges less than 5,000 cfs the creation and maintenance of these habitats would offset the need for velocities to create such habitat. Other habitat characteristics identified as important to the persistence of *Graptemys* within reservoirs include a riparian zone and little lakeside development. The riparian zone will be almost eliminated and development is planned for most of the 971 acres of fill surrounding the improved channel.

Placement of trees as basking habitat would reduce one of the needs for a riparian zone to provide fallen trees for basking and shelter. Velocities used in the Service's analysis are means for the entire cross section of the river. Because the velocities are averages there will be areas throughout the area that will be faster and slower than those presented. Proposed monitoring of the turtle population and created habitat within the Action Area would aid in determining the effectiveness of the created habitat features.

Turtles downstream of the proposed weir are likely to experience short-term impacts associated with increased sediment/siltation on sandbars and basking material during construction. Effectively controlling downstream sediment run-off, especially during high rain events, will be very difficult. However, once sediment runoff issues have dissipated due to high streamflow events, we expect habitat immediately downstream of the weir to remain suitable for the ringed map turtle. We would expect such effects to last less than two years after project completion. Once construction is complete and water pools behind the weir, the mean water depth will increase from approximately 6.7 feet to approximately 21 feet, approximately 14 feet above the existing water surface. If this occurs during nesting season (May to October) it could flood existing nests reducing recruitment from that year's nests. However, filling of the area would likely occur during the higher flow periods, December through May, thus avoiding their nesting time. If filling took place in May it could impact approximately 40 percent of the nests. Details of how the filling will be undertaken have not been finalized but would be coordinated with the Service.

Santucci et al. (2005) studied the impacts of weirs to macroinvertebrates and discovered that species distribution was truncated. Free-flowing river reaches supported a higher quality macroinvertebrate community while pool communities consisted of relatively few taxa dominated by oligochaetes and chrinomid larvae that are more tolerant of poorer water quality. Gangloff (2011) observed that mussel populations upstream of dams had a greater number of historical mussel species. Conversely, Dean et al. (2002) found fewer species but similar abundance upstream and within the influence of the weir resulting from deeper water, slower velocity and silty substrates. Potential upstream impacts to mussels and fish could also result due to changes in tributary velocities upstream of the pool (Roghair et al., 2016). The response of mussels to weirs varies according to individual species tolerance to changes resulting from the weir, including changes in sedimentation rates, suspended sediments, and water quality (Early 2006; Tiemann et al., 2016). It is reasonable to assume that the proposed pool would experience similar changes in macroinvertebrate and mussel communities. Recolonization rates within the channel improvement area would likely occur quickly for invertebrates that could drift downstream and those that disperse aerially. Invertebrates that do not easily disperse (e.g., snail and mussels) would require a longer time period until they fully recolonized the area. Until recolonization is complete the competition for food resources within the channelized area would impact all ringed map turtles within the impoundment.

Cummings (2004) examination of low head dams determined that the biggest issue is anthropogenic influences impacting water quality within the created water body including temperature. Butts and Evans (1978) found that channel dams resulted in lower dissolved oxygen (DO) levels within the pool and the downstream design of the weir influenced the amount of oxygen reintroduced to the water column. Ramped weirs had less re-aeration than water falling over vertical weirs but the greatest influences on DO levels were the water velocity over the dam and the distance water fell. The proposed weir is a vertical weir. Data within the study displays that DO levels within the pool may exhibit wider DO fluctuations typically associated with ponds. Helms et al. (2011) found no physiochemical changes associated with mill dams, and Smith et al. (2017) found that dams did not impact local abiotic factors. Gangloff et al. (2011) found that streams with weirs had lower nitrogen concentrations but observed few statistical differences between habitat variables measured in streams with intact, breached, and relict low-head dams. Santucci et al. (2005) observed that DO and pH levels in pools experienced wide daily fluctuations and at times did not meet state water quality standards. Within the proposed channel improvement area there are eight streams draining approximately 61 square miles of predominately urban areas. Drainage from urban areas typically has increased nutrient loadings and concentrations of pesticides, herbicides, and various hydrocarbon products. High nutrient levels could result in eutrophication of the proposed waterbody. Fluctuations and stratifications in the water quality (e.g., DO) similar to what occurs in the Ross Barnett Reservoir (larger but similar in depth) could be expected. Killebrew et al., (2002) found that even though areas downstream of development were meeting water quality standards there were decreases or localized extirpation of Cagles map turtle. Selman and Jones (2017) cited reports that indicated that prior to improved water quality standards local populations near developed areas were extirpated. Jones and Hartfield (1999) also cited a study that found decreased turtle body size downstream of Jackson. This was attributed to poorer and/or reduced food sources because of decreased water quality and the potential influence of contaminants. Modeling of the project area indicates that water quality should not significantly decline and ringed map turtles are currently persisting in the area with the ongoing discharges. Therefore we believe that while some water quality changes may occur they would not have an adverse effect.

The fish -passage channel would provide approximately 1 mile (0.2 percent of the species range) of flowing water during low flow periods when the channelized area would experience low velocities. Depending on the width and velocities of this feature it could provide additional habitat for the ringed map turtle and would prevent isolation of the populations up and down stream of the weir.

Sediment transport modeling indicates there would be some loss of sediment within the improved channel. Literature regarding the impact of weirs on sediment transport supports that analysis. The loss of sediment will not be comparable to that experienced with large dams but could result in some instability within a limited area downstream of the weir. The Service anticipates approximately 1.6 miles, approximately 0.3 percent of the species range, downstream of the weir would experience some degree of instability that would occur over several years with the capture of small amounts of sediment. Impacts from this would result primarily from an increase in turbidity decreasing potential food sources. The degree of instability and time over which this will occur is unknown but monitoring of this area would be conducted. Eventually, a state of equilibrium would be reached and the impacts would no longer affect the turtle.

Monitoring of the populations within the Action Area would include trapping, tagging and observing, all of which would have some level of disturbance to the turtles. Previous populations studies (i.e., Jones 2017) resulted in the handling of over 1,600 turtles with no known mortality.

6.3.3. Effects of Non-Federal Activities caused by the Federal Action on Ringed Map Turtle

Recreational water sports (e.g., fishing, boating) will likely increase within the improved channel, as well as the Lakeland area, as a result of improved access to the Action Area. This could lead to greater disturbance in basking and nesting behaviors with resulting declines in health and nesting success (Heppard and Buchholz 2019; Selman et al. 2013). Boat wakes can cause shelving of sandbars resulting in turtles nesting in areas closer to the water surface (Selman et al. 2013) which in turn could result in the flooding of turtle eggs and mortality. Because the Service does not know the rate and degree to which recreation will increase, we are unable to estimate the number of nests and individuals potentially impacted. Mortality resulting from boat strikes could also impact the population (Carriere and Blouin-Demers 2010; Selman et al. 2013; Smith et al. 2018). Because larger turtles use deeper water habitats and are typically females, they have an increased potential of being killed, thus reducing their future contribution to the population (Selman et al. 2013; Smith et al. 2018).

No-wake zones would be established around sandbars to reduce the potential impact of both boat strikes and sand bar shelving. No public access would be allowed on the created sandbars thus reducing disturbance to newly created basking habitat and nesting and feeding habitats.

Increased development adjacent to the improved channel could also lead to a decrease in water quality impacting food resources in the improved channel, again the Service is unable to estimate the rate and degree to which this will occur.

Activities that would not occur but for the proposed Federal action include relocation or retrofitting of existing infrastructure within the action area (i.e. roads, bridges, pipelines, powerlines), riverfront access and development. Effects resulting from these activities would include the temporary disturbance to basking, foraging and nesting activities. In addition, temporary and localized increase in turbidity and sedimentation impacts to forage species.

6.3.4. Summary of the Effects of the Action on the Ringed Map Turtle

All the various forms of disturbance (e.g., crowding, displacement) are individually not likely to result in the harm of turtles but collectively they could result in the loss of a portion of the population; this loss is estimated at 1,306 turtles or 2 percent of the entire population across its range. To determine this amount the Service used the mean number of turtles within the two surveyed reaches in the current channelized area and determined what percent of the adjacent population (i.e., more natural areas) they represented. The mid-point between the two average percentages for those two areas was judged to represent a reasonable estimate of the population that could be supported by the proposed channelized area.

The population is expected to undergo an initial decline (from construction mortality) and then a slow decline in the pooled area but would eventually stabilize. Increased survival of adults and hatchlings would occur with the implementation of the above offsetting measures (e.g., no wake zone) resulting in a long-term increase in the population.

6.3.5. Tables and Figures for Effects of the Action on Ringed Map Turtle

Table 6.2. Monthly average discharge (cfs), 1 Standard Deviation (STD) and minimum monthly discharge 1966-2013.

	Jan	Feb	March	April	May	June	July	August	Sept	Oct	Nov	Dec
Average	8333	9303	9101	8183	4312	1562	1154	961	1140	1331	2078	5421
+1 STD	14253	15178	14015	15883	9128	3296	2483	2198	2823	3644	4045	10289
-1 STD	2413	3428	4187	484	-504	-172	-176	-277	-544	-981	111	553
Minimum	338	321	1233	412	256	183	180	197	208	195	142	298

6.4. Cumulative Effects on the Ringed Map Turtle

For purposes of consultation under ESA §7, cumulative effects are those caused by future state, tribal, local, or private actions that are reasonably certain to occur in the Action Area. Future Federal actions that are unrelated to the proposed action are not considered, because they require separate consultation under §7 of the ESA. At this time the Service is unaware of any future state, tribal, local, or private non-Federal actions scheduled to occur in the Action Area. Therefore, cumulative effects are not relevant to formulating our pinion for the Action.

6.5. Conclusion for the Ringed Map Turtle

In this section, we summarize and interpret the findings of the previous sections for the ringed map turtle (status, baseline, effects, and cumulative effects) relative to the purpose of a BO under §7(a)(2) of the ESA, which is to determine whether a Federal action is likely to:
a) jeopardize the continued existence of species listed as endangered or threatened; or
b) result in the destruction or adverse modification of designated critical habitat.
"*Jeopardize the continued existence*" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR §402.02).

The proposed project would affect approximately 19.4 miles of the Pearl River from RM 301.77 to RM 282.4 (i.e., the Action Area) resulting in increased stress to all turtles (approximately 4,960 individuals [7 percent of the total population]) within the Action Area because of a decrease in food sources, basking habitat, and nesting habitat, which in turn increases competition for those resources. Of that 19.4 miles, approximately 9.5 river miles (roughly 2 percent of the species' range) of ringed map turtle habitat would be altered from lotic to lentic habitat for approximately 6 months each year as a result of channel modifications and installation of the weir. Construction of the project and the above habitat alterations would decrease water velocities and temporarily increase turbidity, and would affect turtles as follows:

- a temporary loss of food, basking habitat, and nesting habitat for all turtles (approximately 2,010 individuals) remaining in the channelized area until the pool area is flooded and newly created habitat becomes available;

- a temporary decrease in food resources for approximately 3,360 turtles (roughly 5 percent of the total population) as a result of increased turbidity within and downstream of the construction area; and,
- a direct loss of approximately 281 turtles (roughly 0.4 percent of the total population) due to construction.

To offset or reduce direct losses of turtles due to construction, up to 2,018 eggs would be relocated outside the construction area and protected from predators and 20 individuals (0.03 percent of the total population) would be relocated from Cypress Lake to the Pearl River. In addition, up to 1,600 individuals (1 percent of the total population) would be trapped, tagged, data collected, tracked, observed, and monitored in the Action Area population. While these activities are a form of harassment, no turtles are expected to die from such activities.

In summary, all the various stressors and forms of disturbance, considered separately, are not likely to result in the harm of turtles. However, considered collectively, the combined level of stressors and disturbances could result in the loss of a portion of the population due to harm, estimated at 1,306 turtles. As mentioned above, we also estimate the death of approximately 281 turtles directly from construction activities. Thus, the total estimated take of turtles is 1,588 individuals (approximately 2 percent of the total population).

Additional offsets to turtle losses that would be implemented as part of the Action include: (1) the creation and protection of 31.4 acres of nesting habitat (estimated to produce at least 1,176 nests) and adjacent basking habitat and predator control; (2) the establishment and enforcement of no-wake zones to reduce boat strikes and disturbance during basking; (3) the placement of public access conditions to reduce disturbances to basking and nesting behaviors and habitats (4) the creation of an approximately 1 mile fish by-pass, and (5) the protection of 10 miles of riverbank that would prevent the development and destruction of riparian habitat utilized by the turtle and also reduce nesting and basking disturbances. In total the above offsetting measures have the potential to contribute approximately 2,118 hatchlings following construction (from the relocation of eggs) and 474 hatchlings per year thereafter. Provided that the USACE fully implements those conservation features, the Action is not likely to appreciably reduce the likelihood of the survival and recovery of the ringed map turtle.

After reviewing the current status of the ringed map turtle, the environmental baseline for the Action Area, and the effects of the Action (both detrimental and beneficial activities proposed), it is the Service's biological opinion that implementation of the Action is not likely to jeopardize the continued existence of the ringed map turtle. No critical habitat has been designated for this species; therefore, none will be affected.

7. INCIDENTAL TAKE STATEMENT

ESA §9(a)(1) and regulations issued under §4(d) prohibit the take of endangered and threatened fish and wildlife species without special exemption. The term “take” in the ESA means “to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct” (ESA §3). In regulations at 50 CFR §17.3, the Service further defines:

- "harass" as "an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering;"
- "harm" as "an act which actually kills or injures wildlife. Such act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering;" and
- "incidental take" as "any taking otherwise prohibited, if such taking is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity."

Under the terms of ESA §7(b)(4) and §7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered prohibited, provided that such taking is in compliance with the terms and conditions of an incidental take statement (ITS).

The Action considered in this BO includes a conservation measure to relocate turtles from Crystal Lake within the construction area to the Lakeland population area and monitor the population in the Action Area through the sampling, including but not limited to the capturing, tagging, tracking, observing and taking measurements, of individuals. Through this statement, the Service authorizes this conservation measure as an exception to the prohibitions against trapping, capturing, or collecting listed species. This conservation measure is identified as a Reasonable and Prudent Measure below, and we provide Terms and Conditions for its implementation.

For the exemption in ESA §7(o)(2) to apply to the Action considered in this BO, USACE must undertake the non-discretionary measures described in this ITS, and these measures must become binding conditions of any permit, contract, or grant issued for implementing the Action. USACE has a continuing duty to regulate the activity covered by this ITS. The protective coverage of §7(o)(2) may lapse if USACE fails to:

- assume and implement the terms and conditions; or
- require a permittee, contractor, or grantee to adhere to the terms and conditions of the ITS through enforceable terms that are added to the permit, contract, or grant document.

In order to monitor the impact of incidental take, USACE must report the progress of the Action and its impact on the species to the Service as specified in this ITS.

7.1. Amount or Extent of Take

This section specifies the amount or extent of take of listed wildlife species that the Action is reasonably certain to cause, which we estimated in the "Effects of the Action" section(s) of this BO. We reference, but do not repeat, these analyses here.

7.1.1. Gulf Sturgeon

The Service anticipates that the Action is reasonably certain to cause incidental take of Gulf sturgeon consistent with the definition of harm resulting from channel excavation, levee relocation, and construction of the weir and fish passage channel that would result in impoundment of the Pearl River.

The maximum number of fish, over the five year construction period, that is anticipated to be affected to the level of harm is approximately 20 Gulf sturgeon (4.6 percent of the Pearl River population) due to temporary disturbance to foraging during construction and effects to the decrease in water quality of foraging in the impoundment (see Sections 4.3 and 4.5).

Anticipated Take of Gulf Sturgeon

Amount or Extent	Life Stage	Form of Take
20 fish	Juveniles/Adults	Harm

7.1.2. Ringed Map Turtle

The Service anticipates that the Action is reasonably certain to cause incidental take of individual ringed map turtles consistent with the definition of harm resulting from channel excavation and levee relocation (see section 6.3.1).

The following turtle numbers represents the number of turtles affected by each form of non-lethal harm out of the estimated population within the Action Area, 5,108 turtles; these numbers are not additive.

- We anticipate up to 281 turtles (0.4 percent of the population) may be taken in the form of harm as a result of being killed by machinery during construction.
- We anticipate as many as 2,196 turtles (3 percent of the population) found within the construction limits may be temporary harmed due to construction disturbance of basking, foraging, and nesting activities and fleeing during construction.
- We anticipate as many as 4,366 turtles (6 percent of the population) found within the Action Area may be taken in the form of harm due to the temporary competition for reduced basking, foraging, and nesting habitat as turtles are displaced into other areas.
- We anticipate as many as 3,360 turtles (5 percent of population) found in the improved channel and downstream to be harmed due to reduced forage because of temporary increased turbidity and sedimentation.
- We anticipate that collectively the various forms of harassment (e.g., crowding, displacement) are individually not likely to result in the harm of turtles but collectively they could result in the loss of a portion of the population; this loss is estimated at 1,306 turtles or 2 percent of the entire population.
- We anticipate up to 20 turtles would be taken in the form of harassment due to trapping and relocation from Crystal Lake into the Pearl River.
- We estimate that approximately half of the 1,177 potential nests on the 31.4 acres of sand bar in the excavation area are successfully transferred resulting in the relocation of approximately 2,118 eggs.
- We anticipate harming approximately 1,600 turtles through the trapping, tagging collecting data, tracking, observing and monitoring in the Action Area population

The Service anticipates that the Action is reasonably certain to cause incidental take of individual ringed map turtle consistent with the definition of harass resulting from weir construction and impoundment (see section 6.3.2).

- We anticipate harm from the temporary loss of 9.5 miles of riverine habitat (2 percent of the total range) as velocities would fall below those viewed as suitable for 6 months of the year.
- We anticipate harm due to the approximately 1.6 miles of habitat (0.3 percent of the species range) that would experience instability from loss of sediment transport resulting in increased sedimentation.
- We anticipate harm from the loss of 1 mile of riverine habitat (0.2 percent of the total range) as velocities would exceed those viewed as suitable for most of the year.
- We anticipate up to 1,600 turtles over 15 years would be taken in the form of harassment due to trapping, tagging, tracking and observing for population and movement studies.

Anticipated Take of Ringed Map Turtle

Adverse Action and Associated Take	Amount or Extent*	Life Stage	Form of Take
Trapping, tagging, tracking, and observing; temporary disturbance and stress	1,600 individuals	Adults and juveniles	Harass
Trapping and relocation; temporary disturbance and stress	20 individuals	Adults and juveniles	Harass
Construction; temporary disturbance of basking, foraging, and nesting activities and fleeing	2,196 individuals	Adults and juveniles	Harm
Construction; temporary competition for reduced basking, foraging, and nesting habitat	4,366 individuals	Adults and juveniles	Harm
Construction causing a temporary increased turbidity and sedimentation; decreased forage	3,360 individuals	Adults and juveniles	Harm
Construction machinery impacts; mortality	281 individuals	Adults and juveniles	Harm
Displacement, competition, stress, and reduced habitat quality; mortality	1,306 individuals	Adults and juveniles	Harm

*Numbers for harm do not represent cumulative numbers but portions of the Action Area population impacted by multiple stressor.

7.2. Reasonable and Prudent Measures

The Service believes the following reasonable and prudent measures (RPMs) are necessary or appropriate to minimize the impact of incidental take caused by the Action on listed wildlife species. RPMs are described for each listed wildlife species in the subsections below.

7.2.1. Gulf Sturgeon

RPM 1. The USACE will coordinate with the Service to ensure that completed project plans and updates to specific erosion control and off-site stormwater compensation are implemented and include comprehensive monitoring and reporting.

RPM 2. The USACE will coordinate with the Service on a monitoring and adaptive management plan for the fish passage channel to assess the use of the structure by Gulf sturgeon and other aquatic species.

RPM 3. Water quality assessment plans would be coordinated with the Service.

RPM 4: Ensure that the terms and conditions are accomplished and completed as detailed in this incidental take statement including the completion of reporting requirements.

7.2.2. Ringed Map Turtle

RPM 1 – The USACE will coordinate with the Service on the acquisition, protection, or restoration of riverine habitat for ringed map turtle.

RPM 2 – The USACE will coordinate with the Service on a plan to reduce disturbances and predation in recreated nesting and basking areas.

RPM 3 – The USACE will coordinate with the Service on a filling plan to reduce impacts to nesting areas.

RPM 3 – The USACE will coordinate with the Service on the development of a capture, relocation and monitoring plan for ringed map turtles in Crystal Lake.

RPM 4 – The USACE will coordinate with the Service on the development of a survey and nest relocation plan.

RPM 5 – The USACE shall ensure that all appropriate Project personnel (*e.g.*, inspectors, contractors, equipment operators) are fully aware of the reasonable and prudent measures and the terms and conditions in this ITS, the conservation recommendations which follow this ITS, and of the protection afforded the ringed map turtle under the Endangered Species Act.

RPM 6 – Work with the USACE to determine the feasibility of reforesting the top bank of the fish passage.

RPM 7 – The USACE will develop a plan to reduce take associated with erosion control measures and excavation activities.

RPM 8 – See RPM 1 for the Gulf sturgeon.

RPM 9 – See RPM 3 for the Gulf sturgeon.

7.3. Terms and Conditions

In order for the exemption from the take prohibitions of §9(a)(1) and of regulations issued under §4(d) of the ESA to apply to the Action, the USACE must comply with the terms and conditions (T&Cs) of this statement, provided below, which carry out the RPMs described in the previous section. These T&Cs are mandatory. As necessary and appropriate to fulfill this responsibility, the USACE must require any permittee, contractor, or grantee to implement these T&Cs through enforceable terms that are added to the permit, contract, or grant document.

7.3.1. Gulf Sturgeon

T&C 1. RPM 1. A MDEQ approved erosion and sediment control plan will be submitted and reviewed by the Service prior to start of construction to assure that potential impacts to Gulf sturgeon habitat from sedimentation and turbidity are avoided and minimized to the extent practicable. The Service will be contacted immediately if failures occur in erosion and sediment control measures occur.

T&C 2. RPM 2. Monitoring of the area where the weir and fish passage channel would be constructed pre- and post–construction for usage by aquatic species, in particular the Gulf sturgeon and ringed map turtle.

T&C 3. RPM 2. Annual post-construction water velocity monitoring would be conducted in and around the approaches of the fish passage channel. This assessment would be to evaluate if the velocities exceed swim speed of Gulf sturgeon and submitted at year 1, 2, 4, 6, 8, and 10.

T&C 4. RPM 2. An adaptive management plan would be provided to the Service for the fish passage channel in the event that monitoring of the passage shows that it is not functioning in the manner it was designed to function.

T&C 5. RPM 3. Basic water quality monitoring would be conducted in the project area and downstream of the weir to assess the temperature, turbidity, dissolved oxygen levels, and water velocities, and will be submitted at years 1, 2, 4, 6, 8, and 10.

T&C 6. RPM 4. Upon locating a dead, injured, or sick individual of an endangered or threatened species, notification must be made to the Fish and Wildlife Service Law Enforcement Office, Jackson, Mississippi at (601) 965-4699 within 24 hours. Additional notification to the Fish and Wildlife Service's Field Office at Jackson, Mississippi at (601) 965-4900 within 48 hours will be provided by the USACE. Care should be taken in handling sick or injured individuals and in the preservation of specimens in the best possible state for later analysis of cause of death or injury.

T&C 7. RPM 4. A report describing the actions taken to implement the terms and conditions of this ITS shall be submitted to the Project Leader, U.S. Fish and Wildlife Service, 6578 Dogwood View Parkway, Suite A, Jackson, MS 39213-7856, within 60 days of the completion of the project. This report shall include the dates of work, assessment, and actions taken to address impacts to the ringed map turtle and the Gulf sturgeon, if they occurred.

7.3.2. Ringed Map Turtle

T&C 1. RPM 1. A proposed land acquisition and management plan will be submitted to the Jackson Mississippi Ecological Services Office before construction begins outlining areas to be protected for ringed map turtles, how land will be restored if required, identifying potential threats to turtle habitat and how such threats will be controlled (i.e. public use, predator control, wake zones, etc.), who will oversee land management actions, and how lands will be managed in perpetuity. A minimum of 10 river miles would be protected. Land acquisition will be prioritized accordingly:

- Priority 1 – Protect via fee title or conservation easement or similar encumbrance privately held lands adjacent to the Pearl River in the upstream portion of the Action Area.
- Priority 2 – Protect via fee title or conservation easement or similar encumbrance riverbank (both sides) in that portion of the turtles range north of the Ross Barnett Reservoir.
- Priority 3 - Protect via fee title or conservation easement or similar encumbrance riverbank (both sides) south of the weir.

T&C 2. RPM 2. Monitoring nesting success per Jones 2017; if predation on islands exceeds 73 percent develop in coordination with the Service a plan to reduce predation. Sufficiently mark no wake and no public access areas to ensure compliance, note such areas on project maps, kiosks and pamphlets of the area. Monthly enforcement reporting (number of visits, verbal warnings, and citations) on restricted areas would be provided to the Service.

T&C 3. RPM 3. Develop a filling plan in coordination with the Service that would reduce the chance of flooding during nesting season.

T&C 4. RPM 4. Capture per Jones 2017 ringed map turtles from Crystal Lake prior to construction. PIT and telemetry tag turtles and track for 3 years to further define habitats used and movements throughout the year

T&C 5. RPM 5. Sandbar surveys inside of the planned construction area(s) every 2-days during the nesting season (May 1 – October 3). Surveyed areas would extend 110 feet from the top of the Pearl River bank. The purpose of monitoring during construction is to locate newly formed nests within the construction area(s) and relocate them to sandbars outside the construction area (e.g., Lakeland population) within 36-hours of eggs being laid which will significantly reduce the likelihood of take and predation. Predator guards will be placed on the nests and the nests will be monitored.

T&C 6. RPM 6 and RPM 7. Workers will be given information identifying ringed map turtles and stating the need to avoid injury or death to the turtles, their protected status under the ESA, and contact information for personnel that would respond to any turtles imperiled.

T&C 7. RPM 7. During detailed planning determine the feasibility of replanting trees on the top bank of the fish passage to improve conditions for ringed back turtles. If feasible such restoration would be implemented.

T&C 8. RPM 7. Upon locating a dead, injured, or sick individual of an endangered or threatened species, notification must be made to the Fish and Wildlife Service Law Enforcement Office, Jackson, Mississippi at (601) 965-4699 within 24 hours. Additional notification to the Fish and Wildlife Service's Field Office at Jackson, Mississippi at (601) 965-4900 within 48 hours will be provided by the U.S. Army Corps of Engineers. Care should be taken in handling sick or injured individuals and in the preservation of specimens in the best possible state for later analysis of cause of death or injury.

T&C 9. RPM 7. A report describing the actions taken to implement the terms and conditions of this incidental take statement shall be submitted to the Project Leader, U.S. Fish and Wildlife Service, 6578 Dogwood View Parkway, Suite A, Jackson, MS 39213-7856, within 60 days of the completion of the project. This report shall include the dates of work, assessment, and actions taken to address impacts to the ringed map turtle and the Gulf sturgeon, if they occurred.

T&C 10. RPM 8. Basic water quality monitoring would be conducted in the project area and downstream of the weir to assess the temperature, turbidity, dissolved oxygen levels, water velocities, pH, conductivity, redox, turbidity, nitrates, phosphorous, and chlorophyll will be submitted at years 1, 2, 4, 6, 8, and 10.

7.4. Monitoring and Reporting Requirements

In order to monitor the impacts of incidental take, USACE must report the progress of the Action and its impact on the species to the Service as specified in the ITS (50 CFR §402.14(i)(3)). This section provides the specific instructions for such monitoring and reporting (M&R). As necessary and appropriate to fulfill this responsibility, USACE must require any permittee, contractor, or grantee to accomplish the monitoring and reporting through enforceable terms that are added to the permit, contract, or grant document. Such enforceable terms must include a requirement to immediately notify USACE and the Service if the amount or extent of incidental take specified in this ITS is exceeded during Action implementation.

M&R 1- The USACE will conduct a river morphology monitoring plan for the area upstream of pool to RM 295 and 1.6 miles downstream of weir and submit to the Service.

M&R 2- A report will be submitted once the construction phase is finalized which will include:

- Amount of sand bar habitat created (number, acreage and dimensions of each),

- How sand bars will be maintained (i.e. vegetation monitoring and management),
- How sand bars will be protected (i.e. public use, predator control, wake zones), and
- Amount of basking material remaining, added and location and maintenance plan.

M&R 2- In coordination with the Service and MDFWP develop a monitoring and analysis plan per techniques in Jones 2017 and telemetry for the Channel Improvement Area, Lakeland Population, translocation area and downstream of weir; years 1, 2 and 3 post construction and then every 5 years for 15 years and determine turtle movements

8. CONSERVATION RECOMMENDATIONS

§7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by conducting conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary activities that an action agency may undertake to avoid or minimize the adverse effects of a proposed action, implement recovery plans, or develop information that is useful for the conservation of listed species. The Service offers the following recommendations that are relevant to the listed species addressed in this BO and that we believe are consistent with the authorities of the USACE.

1) Support the future monitoring research efforts for Gulf sturgeon that will be funded through the NRDA Deepwater Horizon Ocean Open Trustee Implementation Group (TIG) through assisting with the monitoring efforts.
2) Funding or supporting research/monitoring efforts for Gulf sturgeon around the weir and fish passage channel. Place monitoring stations in this area to evaluate whether tagged individuals are migrating through the area.
3) Conduct immediate watershed assessment for future impacts.
4) Examine operation of the low flow gate to help aid the downstream flow of sediment.
5) The FDCD will provide an annual operation log of the low flow gate.
6) The FDCD would work with local governments to restrict water craft access to Hanging Moss Creek, Purple Creek, Eubanks Creek, and Town Creek.
7) FDCD would work with Mississippi Department of Wildlife, Fisheries and Parks to restrict the use of hoop nets near nesting beaches.

9. REINITIATION NOTICE

Formal consultation for the Action considered in this BO is concluded. Reinitiating consultation is required if the USACE retains discretionary involvement or control over the Action (or is authorized by law) when:

a. the amount or extent of incidental take is exceeded;
b. new information reveals that the Action may affect listed species or designated critical habitat in a manner or to an extent not considered in this BO;
c. the Action is modified in a manner that causes effects to listed species or designated critical habitat not considered in this BO; or
d. a new species is listed or critical habitat designated that the Action may affect.

In instances where the amount or extent of incidental take is exceeded, the USACE is required to immediately request a reinitiation of formal consultation.

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