Volume IV

APPENDIX A:

Biological Assessment

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Appendix A
Biological Assessment

Small Diversion at Convent/Blind River Project, Louisiana Coastal Area

1.0 Authority

This Supplemental Environmental Impact Statement (SEIS) for the LCA Small Diversion at Convent / Blind River project was prepared in accordance with the National Environmental Policy Act (NEPA) of 1969 and the Council on Environmental Quality's (CEQ) Regulations (40 CFR 1500-1508), as reflected in the United States Army Corps of Engineers (USACE) Engineering Regulation, ER 200-2-2. As the study proceeds this SEIS and subsequent iterations of this document will be closely coordinated between the U.S. Army Corps of Engineers, Mississippi Valley Division, New Orleans District (CEMVN) and other Federal, state, and local agencies, interested parties, and affected individuals. Additionally, it is expected that the U.S. Fish and Wildlife Service (USFWS) will be a cooperating agency. This BA provides information to decision-makers to make determinations on whether to proceed with the engineering and design portions of the project.

Title VII of the Water Resources Development Act (WRDA) of 2007 authorizes the Louisiana Coastal Area Near-term Restoration Plan. The authority includes requirements for comprehensive coastal restoration planning, program governance, project modification investigations, a Science and Technology (S&T) program, restoration project construction, a program for beneficial use of dredged material, feasibility studies for restoration plan components, and other program elements.

The Convent/Blind River Diversion Project is proposed to be a small freshwater diversion from the Mississippi River to the Maurepas Swamp, with a flow rate of 1,000 to 5,000 cfs. The purpose of the project is to reintroduce freshwater, sediment, and nutrients to the swamp, approximating the natural historic flooding cycle to rebuild wetlands at a rate greater than the subsidence rate. This is to improve biological productivity and reverse the current trend of degradation and restore the Swamp.

2.0 Location and General Description of the Project Area

The project area is in the Mississippi River Deltaic Plain in the Upper Lake Pontchartrain Sub-basin. The project area is within St. John the Baptist, St. James, and Ascension Parishes. The project area consists portions of the Maurepas Swamp and Blind River southwest of I-10 (**Figure A.1**).

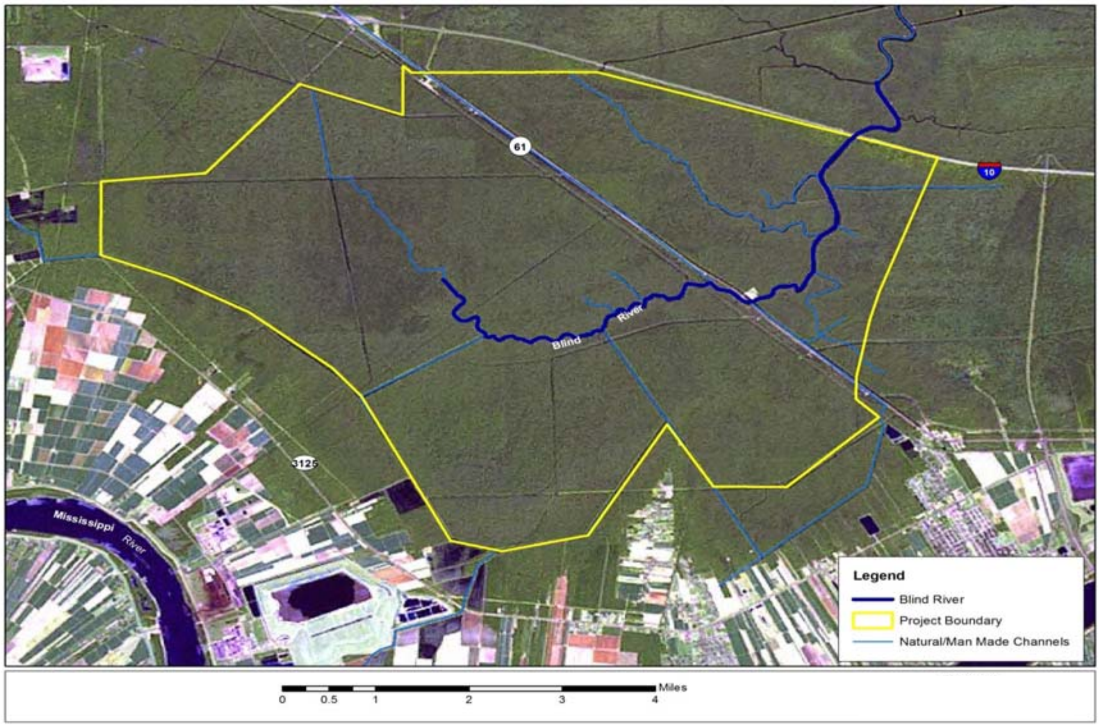

Figure A.1 Project Area

The Maurepas Swamp is one of the largest remaining tracts of coastal freshwater swamp in Louisiana. The Blind River flows from St. James Parish, through Ascension Parish and St John the Baptist Parish, and then discharges into Lake Maurepas.

The Maurepas Swamp serves as a buffer between the open water areas of Lakes Maurepas and Pontchartrain and developed areas along Mississippi River/Airline Highway corridor. Development along this corridor in the project area includes residential, commercial, and industrial land use. The Maurepas Swamp is used for fishing, hunting, and other recreational activities, and as a large contiguous tract of baldcypress-tupelo swamp near the New Orleans metropolitan area, has considerable cultural significance.

As with all of the rapidly disappearing coastal wetlands in Louisiana, the south Maurepas area has been subject to extensive consideration in recent years pursuant to federal and state restoration initiatives. Rapid deterioration of the Maurepas Swamp is expected to continue unless a restoration effort is formulated and implemented as soon as possible and has been noted in several programmatic reports including the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA, 1993), the Louisiana Coast 2050 report (1998), which provided a more strategic and participation-based approach to restoration, and the Mississippi River Sediment, Nutrient and Freshwater Diversion study (1999), which looked specifically at projects for restoration by means of diverting Mississippi River water into wetlands, including the south Maurepas swamps. All these studies have identified the south Maurepas as an area where wetlands vegetation (especially the cypress-tupelo swamp) is stressed and dying, and in need of restoration.

3.0 Proposed Action

The main components of the tentatively selected plan (TSP), a 3,000 cfs diversion from the Mississippi River at Romeville, consist of three gated culverts, a 3-mile long transmission canal, five concrete drainage control structures, thirty new berm gaps approximately 500 feet wide each, the widening of 160 existing berm gaps and three culverts at the railroad/Hwy 61 crossing (Figure A-2).

4.0 Species Descriptions

Within the State of Louisiana there are thirty animal and three plant species (some with critical habitats) under the jurisdiction of the USFWS and/or the NMFS that are presently classified as endangered or threatened. The USFWS and the NMFS share jurisdictional responsibility for sea turtles and the Gulf sturgeon. After coordination with state and federal agencies, it has been determined that the proposed action would potentially impact the Gulf sturgeon (*Acipenser oxyrhynchus desotoï*), pallid sturgeon (*Scaphirhynchus albus)* and West Indian manatee (*Trichechus manatus*). Therefore, more detailed descriptions of listed species follow.

4.1 Gulf Sturgeon

Status:

On September 30, 1991, the Gulf sturgeon was listed as a threatened species under the ESA, and the USFWS designated critical habitat for this species throughout its range on February 28, 2003. In Louisiana, Gulf sturgeon critical habitat includes the Pearl River System in Washington and St. Tammany Parishes, the Bogue Chitto River, as well as Lake Pontchartrain, Lake Borgne, Lake Catherine, and the Rigolets (Federal Register Volume 68, No. 53). According to the final critical habitat designation, elements essential for Gulf sturgeon conservation are habitat components supporting feeding, resting, sheltering, reproduction, and migration.

Species and Habitat Description:

The Gulf sturgeon, also known as the Gulf of Mexico sturgeon, is an anadromous fish (i.e. a fish that breeds in freshwater after migrating from marine or estuarine environments). The Gulf sturgeon inhabits coastal rivers from Louisiana to Florida during spring and summer, and the estuaries, bays, and marine environments of the Gulf of Mexico during fall and winter. 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 tail (caudal fin) is distinctly asymmetrical; the upper lobe is longer than the lower lobe (heterocercal). Adults range from 4 to 8 feet (1.2 to 2.4 meters) in length, with adult females larger than adult males.

Gulf sturgeon are long-lived, with some individuals reaching at least 42 years of age (Huff, 1975). Age at sexual maturity for females ranges from 8 to 17 years, and for males from 7 to 21 years (Huff, 1975). In the spring (from late February to mid-April) when the river surface temperatures are 63 to 70 degrees Fahrenheit (ºF) (17 to 21 degrees Celsius [ºC]), sexually mature, males and females migrate into rivers to spawn (Carr, Tatman, and Chapman, 1996). It is believed that Gulf sturgeon exhibit a spawning periodicity similar to Atlantic sturgeon, with females spawning at intervals ranging from every 3 to 5 years, and males every 1 to 5 years (Smith, 1985, see http://www.fws.gov).

Gulf sturgeon eggs are demersal (i.e. they sink to the bottom), adhesive, and vary in color from gray to brown to black (Vladykov and Greeley, 1963; Huff, 1975; Parauka et al., 1991). Sturgeon require hard substrates for eggs to adhere to and to provide shelter for developing larvae (Sulak and Clugston, 1998, see http://www.fws.gov). Young-of-the-year Gulf sturgeon appear to disperse widely, using extensive portions of the river as nursery habitat. They are typically found on sandbars and sand shoals over rippled bottom and in shallow, relatively open, unstructured areas.

Gulf sturgeon feeding habits in freshwater vary depending on the fish's life history stage. Young-of-the-year Gulf sturgeon remain in freshwater feeding on aquatic invertebrates and detritus approximately 10 to 12 months after spawning occurs (Mason and Clugston, 1993; Sulak and Clugston, 1999, see http://www.fws.gov). Juveniles less than 11 lbs (5 kg) are believed to forage extensively and exploit scarce food resources throughout the river, including aquatic insects (e.g., mayflies and caddis flies), worms (oligochaetes), and bivalve mollusks (Huff, 1975; Mason and Clugston, 1993). Subadults (age 6 to sexual maturity) and adults (sexually mature) only feed in marine and estuarine habitats and are thought to forage opportunistically (Huff, 1975) on primarily benthic invertebrates. Gut content analyses have indicated that, at this life stage, the Gulf sturgeon's diet is predominantly amphipods, lancelets, polychaetes, gastropods, shrimp, isopods, mollusks, and crustaceans (Huff, 1975; Mason and Clugston, 1993; Carr, Tatman, and Chapman, 1996b, see http://www.fws.gov; Fox et al., 2000, see http://www.fws.gov; Fox et al., 2002, see http://www.fws.gov).

When river temperatures drop in the fall to about 63 to 72°F (17 to 22°C), Gulf sturgeon return to the coastal shelf areas of the Gulf of Mexico (Carr, Tatman, and Chapman, 1996, see http://www.fws.gov). Most subadult and adult Gulf sturgeon spend the cooler months in estuarine areas, bays, or the Gulf of Mexico feeding (Odenkirk, 1989; Foster, 1993; Clugston et al., 1995; Fox et al., 2002, see http://www.fws.gov). Winter habitats used by Gulf sturgeon coincide with the habitats of their prey. Non-spawning sturgeon appear to feed longer in the estuaries and bays prior to moving into the rivers than spawning adults (Fox et al. 2000, in USACE 2006).

Range and Population Dynamics:
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, with infrequent

sightings occurring west of the Mississippi River. 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, a gelatin used in food products and glues (Huff, 1975; Carr, 1983). Gulf sturgeon numbers declined due to over fishing throughout most of the 20th century. After 1950, the decline was exacerbated by habitat loss associated with the construction of water control structures, such as dams and sills. In several rivers throughout the species' range, dams have severely restricted sturgeon access to historic migration routes and spawning areas (Boschung, 1976; Wooley and Crateau, 1985; McDowall, 1988). Gulf sturgeon exhibit a high degree of fidelity, with over 99 percent returning to spawn in the same river system in which they were hatched (USACE, 2006).

Sampling was conducted for Gulf sturgeon in Lake Maurepas during November 2005 through June 2006 using gill nets with stretch mesh panels and otter trawls (Kirk et al. 2007). Concurrently, mobile sonic telemetry along a systematic grid was used to locate any of approximately 40 Gulf sturgeon telemetry tagged in the Pearl River system during 2001 through 2006. No Gulf sturgeon were detected (via telemetry) nor captured using trawls or experimental gill nets in Lake Maurepas (Kirk et al. 2007).

Management and Protection:
Life history characteristics of Gulf sturgeon may complicate and protract recovery efforts. Gulf sturgeon cannot establish a breeding population rapidly because of the amount of time it takes them to reach sexual maturity. Further, Gulf sturgeon appear to be river-specific spawners, although immature Gulf sturgeon occasionally exhibit plasticity in movement from one river to another. Therefore, natural repopulation by Gulf sturgeon migrating from other rivers may be non-existent or very low. The take of Gulf sturgeon is prohibited in the state waters of Louisiana, Mississippi, Alabama, and Florida. Section 6(a) of the ESA provides for extended cooperation with states for the purpose of conserving threatened and endangered species. Under that provision, the Departments of the Interior and Commerce may enter into cooperative agreements with a state, provided that state has an established program for the conservation of a listed species. The agreements authorize the states to implement the authorities and actions of the ESA relative to the listed species recovery. Specifically, the states are authorized: 1) to conduct investigations to determine the status and requirements for survival of resident species of fish and wildlife (this may include candidate species for listing), and 2) to establish programs, including acquisition of land or aquatic habitat or interests for the conservation of fish and wildlife. Federal funding is also provided to states under those agreements to implement the approved programs. All four of the above mentioned states have entered into Section 6 agreements with the USFWS.

4.2 Pallid Sturgeon

Status:
The pallid sturgeon was listed as endangered by the U.S. Endangered Species Act on June 9, 1990. The species is adapted to large, free-flowing turbid rivers with a diverse

assemblage of physical characteristics that are in a constant state of change. Detailed habitat requirements of this fish are not known, but it is believed to spawn in Louisiana. The decline of this species is attributed to flood control and navigation projects, pollution, and overexploitation for caviar (Dryer and Sandvol 1993). Natural reproduction and recruitment is extremely low and long term trends have populations declining at a rate of 25-50 percent. Ongoing stocking of hatchery-produced sturgeons is an attempt to supplement natural populations.

Species and Habitat Description:
The pallid sturgeon is a large fish with a heterocercal tail, a long slender caudal peduncle, a flat shovel-shaped snout, four fringed barbells on the snout, a ventral mouth, and large bony scutes on the head, back, and sides. It is similar in appearance to the shovelnose sturgeon. The pallid sturgeon feeds opportunistically on aquatic insects, crustaceans, mollusks, annelids, fish eggs, and sometimes other fish.

The pallid sturgeon occupies large, turbid, free-flowing riverine habitat. It occurs in strong current over firm gravel or sandy substrate. Pallid sturgeons tend to select main channel habitats in the Mississippi River and main channel areas with islands or sand bars in the upper Missouri River.

Spawning season goes from June to August. Specific characteristics of spawning habitat have not been documented. Larvae drift downstream from the hatching site. Males sexually mature in 3-4 years and females likely take at least several years to mature. Individuals probably spawn at intervals of several years, resulting in very slow reproductive rates. The pallid sturgeon is known to live up to 41 years in the wild.

The pallid sturgeon was formerly harvested commercially and is considered a fine eating fish. In addition, its roe is considered suitable for caviar and its size makes it a desirable trophy sport fish. Despite being protected throughout its range, illegal harvests continue to threaten the small remaining populations.

Range and Population Dynamics:
The range of the pallid sturgeon includes the Mississippi and Missouri Rivers and several of their major tributaries. Substantial populations are also found in the Atchafalaya River in central Louisiana. Population numbers have been estimated to be as few as 6,000 individuals or as many as 21,000 (Lee et al. 1980; Killgore et al. 2007). Sampling has revealed that the largest population occurs in the Atchafalaya River. This southern population numbers in the few thousands. Pallid sturgeon have been documented in the Mississippi River as far south as Donaldsonville, Louisiana, but likely occur below New Orleans albeit at relatively low numbers. Populations in the lower Mississippi River are probably stable but long-term studies are required to fully evaluate population trends and habitat preferences (Killgore et al. 2007).

Natural reproduction is evident in some areas along the Missouri, Mississippi, and Atchafalaya rivers, but natural recruitment continues to be limited throughout the range. As a result, the wild population is declining. It remains to be seen whether or not ongoing releases of hatchery-reared juveniles will lead to increases in the spawning population.

As of November 2009, the ERDC Ecological Fish Surveying Team has been unable to sample the Mississippi River for pallid sturgeon near the proposed Blind River/Convent diversion sites due to high river stages. Sampling is planned to resume once river conditions improve (Thomas Parker, personal communication, 11/10/09). However, in 2005-2006, Pallid sturgeon in the Mississippi River were sampled with trawls and trotlines. Age-0 and juvenile pallid sturgeon were sampled during August 2005 and monthly from April through June 2006. Abundance was measured in cooler months (December 2005 through April 2006) using trotlines. Sites included: sandy bars above and below the Hope Canal diversion site, in the main channel at the bridge at Gramercy, Louisiana, and near a petroleum loading dock close to the proposed Hope Canal diversion site (Kirk et al. 2007).

Extensive trawling captured no age-0 or juvenile pallid sturgeon at any location in the Mississippi River near the proposed water diversion site. A total of 10 pallid and 24 shovelnose sturgeon were captured using trotlines from early December of 2005 through April 2006 (Kirk et al. 2007). These fish were captured at a single location: at the edge of the main channel of the Mississippi River at the Gramercy Bridge. The habitat near the bridge was at the edge of the main channel in depths of 17.5 to 22.6 m, current velocities ranged from 0.3 to 1.3 m/sec, and water temperatures ranged from of 8.2 to 16.6° C (Kirk et al. 2007). The sloping bottom was predominately sand with some gravel.

Sub-adult and adult and pallid sturgeon are relatively abundant in the project area, but no small sturgeon were collected. Juvenile pallid sturgeon are rarely collected during surveys of naturally reproducing populations, and low numbers of juveniles is presumably due to specialized habitat requirements and very rapid growth of young fish. Spawning habitat of pallid sturgeon (i.e., gravel beds in swift water) was not apparent in the project area, and it is possible that juveniles do not occur in the area because spawning is taking place elsewhere (Kirk et al. 2007).

Management and Protection:
The pallid sturgeon is now federally protected throughout its range. Illegal harvesting and the construction of water diversions continue to be major threats caviar (Dryer and Sandvol 1993). Lack of accurate population information has made conservation measures difficult. Monitoring programs utilizing trawling sampling methods are being conducted in the lower Mississippi River near the Convent/Blind River project site to help ascertain accurate population numbers.

In an effort to elevate population numbers, hundreds of thousands of juveniles are produced and released annually via artificial propagation and captive spawning of wild-caught adults in accordance with the pallid sturgeon stocking and augmentation plan. Hatchery-reared pallid sturgeons appear to be essential in preventing local extirpation in portions of its range and have been used to re-establish the species in localized areas. However, it is too early to determine if these captive-raised fish will spawn and naturally reproduce.

4.3 West Indian Manatee

Status:

The West Indian manatee was listed as endangered throughout its range for both the Florida and Antillean subspecies in 1967, and received Federal protection with the passage of the ESA in 1973. Critical habitat was designated in 1976, 1994, 1998, 2002, and 2003 for the Florida subspecies.

Species and Habitat Description:

The West Indian manatee is a large gray or brown aquatic mammal. Adults average approximately 10 feet (3 m) in length and weigh up to 2,200 pounds (999 kg). They have no hind limbs, and their forelimbs are modified as flippers. Manatee tails are flattened horizontally and rounded. Their body is covered with sparse hairs and their muzzles with stiff whiskers (USFWS, 2001c). The nostrils, located on the upper snout, open and close by means of muscular valves as the animal surfaces and dives (Husar, 1977; Hartman, 1979). Manatees will consume any aquatic vegetation (i.e., submerged, floating, and emergent) available to them and sometimes even shoreline vegetation. Although primarily herbivorous, they will occasionally feed on fish. Manatees may spend about five hours a day feeding, and may consume four to nine percent of their body weight per day.

Observations of mating herds indicate that females mate with a number of males during their 2- to 4-week estrus period, and then they go through a pregnancy estimated to last 12 to 14 months (O'Shea et al., 1992). Births occur during all months of the year with a slight drop during winter months. Manatee cows usually bear a single calf, but 1.5 percent of births are twins. Calves reach sexual maturity at three to six years of age. Mature females may give birth every two to five years (USFWS, 2001c).

Manatees inhabit both salt and freshwater of sufficient depth (5 feet [1.5 m] to usually less than 20 feet [6.1 m]) throughout their range. Shallow grassbeds with ready access to deep channels are preferred feeding areas in coastal and riverine habitats (USFWS, 2001c). They may also be encountered in canals, rivers, estuarine habitats, saltwater bays, and have been observed as much as 3.7 miles (6.0 km) off the Florida Gulf Coast. Between October and April, Florida manatees concentrate in areas of warmer water. Severe cold fronts have been known to kill manatees when the animals did not have access to warm water refuges. During warmer months they appear to choose areas based on an adequate food supply, water depth, and proximity to fresh water. Manatees may not need fresh water, but they are frequently observed drinking water from hoses, sewage outfalls, and culverts.

Range and Population Dynamics:
Between October and April, Florida manatees concentrate in areas of warmer water. During these winter months, the United States' manatee population confines itself to the coastal waters of the southern half of peninsular Florida and to springs and warm water outfalls as far north as southeast Georgia. Severe cold fronts have been known to kill manatees when the animals did not have access to warm water refuges. During the summer months, they migrate as far north as coastal Virginia on the east coast and the Louisiana coast in the Gulf of Mexico (USFWS, 2001c). They appear to choose areas based on an adequate food supply, water depth, and proximity to fresh water.

During summer months, manatees disperse from winter aggregation areas, and are commonly found almost anywhere in Florida where water depths and access channels are greater than 3.3 to 6.6 feet (1.0 to 2.0 m) (O'Shea, 1988). In the warmer months, manatees usually occur alone or in pairs, although interacting groups of five to ten animals are not unusual (USFWS 2001c).

In the early 1980s, scientists tried to develop procedures for estimating the overall manatee population in the southeastern United States (USFWS, 2001c). The best estimate throughout the State of Florida was 1,200 manatees (Reynolds and Wilcox, 1987). In the early 1990s, the State of Florida initiated a statewide aerial survey in potential winter habitats during periods of severe cold weather (Ackerman, 1995), and the highest count of 3,276 manatees was recorded in January 2001.

Manatee occurrences appear to be increasing, and they have been regularly reported Amite, Blind, Tchefuncte and Tickfaw Rivers, and in canals in adjacent coastal marshes of Louisiana. (USFWS letter, march 4, 2010) While rare, the potential exists for the manatee to be within the project area.

Management and Protection:
The most significant problem faced by manatees is death or injury from boat strikes (USFWS, 2001c). Populations may also be adversely affected by cold weather and red tide outbreaks. Minimum flows and levels for warm water refuges need to be established to ensure their long-term availability for manatees. Their survival will depend on maintaining the ecosystems and habitat sufficient to support a viable manatee population (USFWS, 2001c). The focus of recovery is on implementing, monitoring, and addressing the effectiveness of conservation measures to reduce or remove threats that will lead to a healthy and self-sustaining population (USFWS, 2001c).

In addition to protection under the ESA, the West Indian manatee is protected under the Marine Mammal Protection Act (MMPA) of 1972. The MMPA establishes a national policy for the maintenance of health and stability of marine ecosystems and for obtaining and maintaining optimum sustainable populations of marine mammals. It includes a moratorium on the taking of marine mammals. The recovery planning under the ESA includes conservation planning under the MMPA (USFWS, 2001c).

4.4 Bald Eagle

Status:

Except for the distinct Sonoran Desert population segment in Arizona, the bald eagle was removed throughout its range from the federal list of U.S. threatened and endangered species on August 9, 2007. To ensure the eagles continue to thrive, the U.S. Fish and Wildlife Service is working with the Louisiana Department of Wildlife and Fisheries to monitor eagles for at least five years. If it appears that bald eagles again need the protection of the Endangered Species Act, the service can propose to relist the species. Even though they are delisted, the bald eagle is still protected by the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act. These laws require measures to continue to prevent bald eagle take resulting from human activities.

Species and Habitat Description:

Adult bald eagles have a dark brown body and distinctive white head and tail. Unlike their parents, juveniles have mottled brown and white plumage. As they mature, juvenile eagles gradually acquire their adult plumage over the course of five years. Most bald eagles reach breeding age at 4-5 years old, but many delay breeding until much older. In the wild, bald eagles may live 15 to 25 years.

Bald eagles are opportunistic feeders with fish comprising the majority of their diet. They will also prey on waterfowl, shorebirds, colonial waterbirds, small mammals, turtles, and carrion. Because they rely on vision to hunt, eagles typically locate their prey from a perch and then swoop down and strike.

In the southeast, bald eagles generally nest and breed between October and May. The nesting season begins with courtship and nest building. During the nesting season, eagles occupy and defend a territory. A territory may include an active nest and alternative nests that are built and maintained but not used every year. Nests are usually located near large bodies of water in mature or old-growth trees, snags, and rock outcrops. In the project site, nests are located in the tallest cypress trees with limbs that can support a nest that can weigh more than 1000 pounds. Most egg laying is completed by November and the eggs hatch at the end of the year. Clutch size generally ranges from 1-3 and incubation lasts 5 weeks, by both sexes but the female rarely leaves the nest. The eggs incubate for about 35 day. The laying of eggs to first flight normally takes 16 to 18 weeks. Eagles grow fast and can fly after 78 to 80 days. Active eagle nests in Louisiana are currently producing eaglets at an average rate of 1.32 per nest per year.

Bald eagles prefer habitats close to coastal areas, bays, rivers, lakes, or other bodies of water that reflect an availability of prey sources. By May, most eagles in Louisiana have left the state and spend summers in the northern states. Communal roost sites are common, especially in sheltered sites during the winter.

Range and Population Dynamics:
In 1972, there were only six or seven nesting sites in Louisiana. The Louisiana Department of Wildlife and Fisheries began making aerial surveys to monitor known existing eagles in 1984. By 1985, the number of active nests had increased to 18. In 2004, there were 234 known nests. Terrebonne Parish in south Louisiana is believed to contain the most breeding pairs and hosts about 60 active nesting sites.

Eagles appear to be expanding into newer areas near interior fresh-water lakes and reservoirs. Most of the known nests are located in the marshes between the Mississippi River and Vermillion Bay. Those marshes are attractive to eagles because of abundant food sources and large cypress trees which are used as nesting sites.

Management and Protection:
The U.S. Fish and Wildlife Service also provides management guidelines and conservation measures to protect the bald eagle when they are most sensitive to human disturbance—during the nesting and wintering periods. The bald eagle nesting period consists of 5 phases: courtship and nest building, egg laying, incubation and hatching, early nestling, and late nestling. Eagles are most sensitive to human disturbance during the courtship and nest building phase. It is during this period that eagles are most likely to abandon nest sites. In Louisiana, this phase generally occurs between October and January. Even if human disturbance is avoided during the critical first phase, eagles continue to be extremely sensitive until the young have fledged in April.

4.5 Wading Bird Colonies

Common colonial wading birds that have been observed in southern Maurepas Swamp include black-crowned night-heron, great blue heron, great egret, green heron, little blue heron, snowy egret, tri-colored heron, white ibis, and yellow-crowned night-heron, with anhinga a commonly associated water bird. Despite the high species richness, densities are typically low, and large nesting colonies are absent or rare within the swamp, suggesting that suitable habitat may be limited (Stouffer et al 2005).

Although wading bird nesting colonies were not observed within the project area, several wading bird species have nesting colonies located within an 8 mile radius to the project site (**Figure A.2**). The status of these colonies, located to the north and east of the project area, is unknown (LNHP 2004). The species represented include the

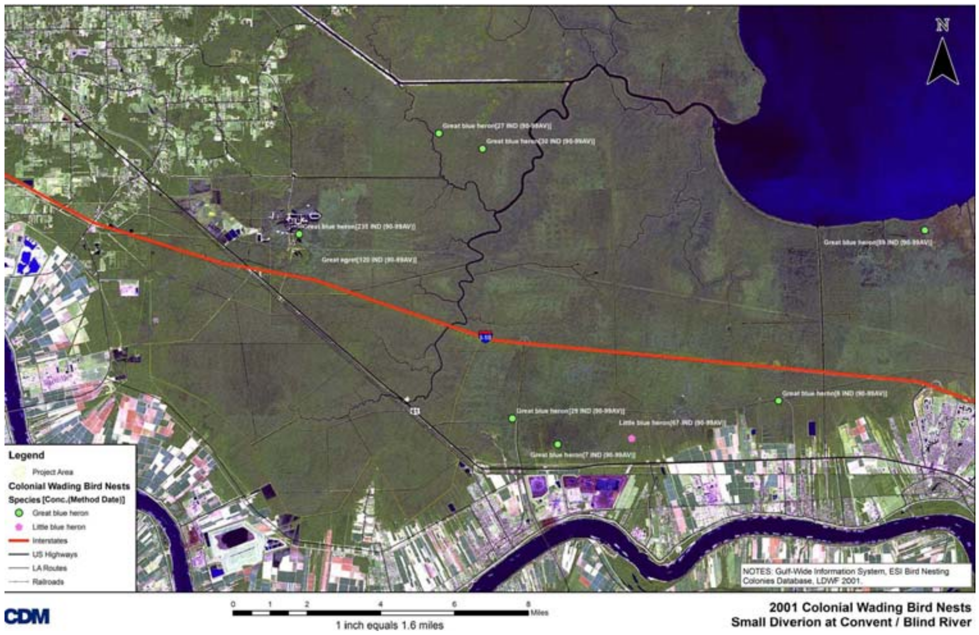

Figure A.2. Location of Nearby Wading Bird Colonies

great blue heron, great egret, and little blue heron. Although these species are not listed as threatened or endangered, these breeding and nesting areas are of special interest and efforts should be made to lessen impacts. Brief species descriptions are included below:

Great Blue Heron:

According to a 2001 survey, there are nine great blue heron colonial nesting sites located in close proximity to the blind river diversion project area. Nesting colonies are often comprised of a few to hundreds of pairs and may include other heron species. Nests are generally located high in trees or on rock ledges in swamps and forested areas close to foraging habitat. Clutch size is 3-7 and both parents incubate the eggs over the 25-29 day period. Both parents also tend to the young which stay in the nest for 60-90 days. Fledging success depends importantly on the success of parents in providing sufficient food when nestlings are 2-6 weeks old. The great blue heron is considered secure and common in the region and is a species of least concern. Population numbers have been increasing in the area and are predicted to remain stable through at least 2050 (2050 Report).

Little Blue Heron:

According to a 2001 survey, there is one recorded little blue heron colonial nesting site located approximately four miles to the east of the project site north of US-61. Little blue herons are wading birds that prefer low gradient, shallow freshwater habitats in which they forage for small aquatic animals and insects. Nests are often found in trees and shrubs to about 4 meters above the ground or water, primarily adjacent to freshwater foraging areas. Clutch size is 3-6 and both sexes incubate the eggs during the 22-24 day incubation period. The young can leave the nest within 12 days and fledge within 4 weeks. Although not observed as frequently as the great blue heron, the little blue heron is considered secure and common in the region and is a species of least concern. Population numbers have been increasing in the area and are predicted to remain stable through at least 2050 (2050 Report).

Great Egret:
According to a 2001 survey, there is one recorded great egret nesting colony located approximate one mile north of the project site to the north of I-10. This colony is the closest of all recorded nearby rookeries, and therefore, is the most likely to be affected by the implementation of the diversions. They prefer low gradient, shallow water habitats including marshes, wooded swamplands, and tidal estuaries. Great egrets generally nest in tall trees with other colonial water birds. They commonly return to the same colony sites year after year. Clutch size of 2-3 is common, and incubation of the eggs by both parents lasts 23-25 days. Young are fledged at 6 weeks. Great egrets are considered common and secure throughout Louisiana and are a species of least concern. Population numbers have been increasing in the area and are predicted to remain stable through at least 2050 (2050 Report).

5.0 Potential Effects of the Proposed Action

The potential exists that any of the endangered or threatened species listed or species of special note may be present during proposed construction activities. However, while individuals may be affected, it is unlikely that whole populations would be adversely affected by implementation of the proposed action.

5.1 Gulf Sturgeon

<u>Potential Impacts of Water Diversion:</u>

According to NMFS, there is no critical habitat designated for Gulf sturgeon in the Blind River project area (Kimberly Clements, personal communication, 8/4/09). In addition, the USACE Engineer Research and Development Center developed a report in June 2008 that evaluated the potential impacts of Lake Maurepas diversion projects to Gulf and pallid sturgeon. The report determined Gulf sturgeon were unlikely to be affected by the diversion due to their absence in nearby stretch of the Mississippi River.

A risk assessment for entrainment of Gulf sturgeon was not performed since this species is unlikely to be in this reach of the Mississippi River and thus unlikely to be entrained. However, Gulf sturgeon are likely use or move through Lake Maurepas from tributary rivers on their annual migration to and from marine habitats. Therefore, potential project effects on the water quality of Lake Maurepas and their impacts on sturgeon must be examined. In that regard, a review of the literature of Gulf sturgeon movements is instructive in understanding when Gulf sturgeon are likely to use Lake Maurepas and thus be influenced by project impacts (i.e. decreasing salinity and lower water temperatures).

Although some Gulf sturgeon may reside in Lake Maurepas, as they are known to do in Lake Pontchartrain, their use of the lake is likely to be during October or November and again during their return from marine habitats in the Mississippi Sound during February through April (ERDC 2008). Since these fish are moving into or out of saline habitats and are not feeding, changes in temperature or salinity caused by the diversion of water from the Mississippi River seem unlikely to adversely impact their populations.

5.2 Pallid Sturgeon

Adult pallid sturgeon were collected only near the steep, vertical banks (sandbar "reefs") close to the Gramercy bridge. This habitat is similar to the littoral habitat of the proposed Blind River/Convent diversion sites. Consequently the probability of use of the site where the diversion structure will be constructed is high and very certain for sub-adult and adult fish.

Potential Impacts of Water Diversion:

Susceptibility of fish to the proposed culvert is high for juveniles, sub-adults and adults. Pallid sturgeon in the Mississippi River are frequently found in the vicinity of man-made structures (e.g., dikes). Such structures provide attractive areas of shelter from main channel water velocities. They also provide hard, permanent substrates for benthic invertebrates and fishes eaten by pallid sturgeon (Hoover et al. 2007). The likelihood that pallid sturgeon of any size would exploit a culvert (and any associated embayment) as a refuge and/or feeding ground is high.

Susceptibility to water velocities in the culvert is high for juveniles, but only moderate for sub-adults and adults due to greater swimming capabilities of larger fish. Swimming speeds, based on endurance, however, are highly variable among (and within) age classes. Escape speeds (i.e., swimming speeds that can be maintained for up to one minute) have been measured for juvenile pallid sturgeon 74-205 mm FL and range from 35-75 cm/s (Hoover et al. 2005). Escape speeds for sub-adult and adult pallid sturgeon have not been measured but are probably in excess of 120 cm/s. This estimate is based on data for shovelnose sturgeon which have nearly identical swimming endurance to pallid sturgeon (Adams et al. 1997). If flows approach this range, entrainment of most juveniles and some of the slower-swimming larger fish would be likely.

Risk of pallid sturgeon entrainment could be reduced in several ways. Withdrawal of water from the surface of the river would make entrainment less likely since pallid sturgeon swim close to the river bottom and rarely approach the water's surface (Kirk et al. 2007). Also, larger gates, or a greater number of gates, to distribute flow would make it possible for sturgeon to resist flow by creating water velocities lower than recorded and estimated escape speeds (Kirk et al. 2007). Rough or complex substrates (e.g., scarified concrete, rip rap, etc.) directly in front of the gates would also enable pallid sturgeon to resist entraining flows by providing low-velocity boundary layers and by enabling alternative low-energy station-holding behaviors such as creeping, hunkering, and tail-bracing to be used by fish (Hoover et al. 2005). Seasonal restrictions on diversion could minimize likelihood of entraining spawning adults (e.g., early spring) or juveniles (e.g., late spring, early summer).

Since some entrainment of pallid sturgeon is possible, mitigation strategies should at least be considered and studied. Due to brood stock availability, genetic and behavioral considerations, and a lack of understanding of sturgeon demographics, culture and release of pallid sturgeon should be a last option (Kirk et al. 2007). Mitigation resources would be better used in gaining an improved understanding of pallid sturgeon demographics, swimming capabilities, and the hydraulic characteristics of the diversion structure (Kirk et al. 2007). If studies show that the local population of pallid sturgeon is robust, then some incidental losses will likely have little impact upon the population.

Due to documented populations near the diversion site, the proposed project activities have the potential to adversely affect pallid sturgeon. However, the entrainment risk is low for juveniles due to low likelihood of occurrence in the project area, and moderate for sub-adults and adults due to presumed lower limits on swimming capabilities of some individual fish

5.3 West Indian Manatee (*Trichechus manatus)*

Should any manatees be encountered during the proposed activities, an on-board observer would notify the proper personnel, and harmful activities (e.g., dredging) would be temporarily suspended until the animal(s) moves out of the area of operations. Any disturbance to the manatee would only be temporary during construction activities, and would result in temporary displacement. The manatees would likely move and relocate to other nearby areas for foraging or resting purposes.

Because the West Indian manatee may occur in the project vicinity, the Contractor shall instruct all personnel associated with the project of the potential presence of manatees in the area, and the need to avoid collisions with these animals. All construction personnel shall be advised that there are civil and criminal penalties for harming, harassing, or killing manatees, which are protected under the Marine Mammal Protection Act of 1972 and the Endangered Species Act of 1973. The Contractor shall be held responsible for any manatee harmed, harassed, or killed as a result of construction activities not conducted in accordance with these specifications.

Special Operating Conditions If Manatees Are Present in the Project Area

If a manatee(s) is sighted within 100 yards of the project area, all appropriate precautions shall be implemented by construction personnel to ensure protection of the manatee. These precautions include the operation of all moving equipment no closer than 50 ft of a manatee. If a manatee is closer than 50 ft to moving equipment or the project area, the equipment will be shut down and all construction activities will cease. Construction activities will not resume until the manatee has departed and the 50-foot buffer has been re-established.

In addition, if a manatee(s) is sighted in the project area, all vessels associated with the project shall operate at "no wake/idle" speeds at all times while in waters where the draft of the vessel provides less than a four-foot clearance from the bottom, and vessels will follow routes of deep water whenever possible. If siltation barriers are used, they will be made of material in which manatees cannot become entangled, are properly secured, and are regularly monitored to avoid manatee entrapment. Any sightings of manatees, or collisions with a manatee, should be reported immediately to the Corps of Engineers.

5.4 Bald Eagle

The local population of nesting Bald Eagles in the Maurepas Swamp has increased steadily since 1988, and productivity is stable (Stouffer et al. 2005). In 2005-2006, the 17 active Bald Eagle nests in Maurepas Swamp constituted nearly 6% of the active nests in Louisiana (Stouffer et al. 2005). Three active nests have been located within project boundaries, and October 2009 field surveys documented several eagle observations One of the nests, nest 134B, is located far enough away from proposed construction activities that impacts should be minimal. However two nests, nest 393 and 174 (presently inactive at last report), are located relatively close to diversion alternatives. Nest 393, in particular, is located within several hundred yards of the terminus of the proposed Romeville diversion alternative. Therefore, measures must be taken to avoid impacting the eagles, especially during the breeding season. Specific measures will be discussed below.

<u>Effects of Diversion Construction on Bald Eagles</u>
Construction activities within the project area that encompasses the Maurepas Swamp may come into contact with bald eagles. Bald eagles migrate north in mid-May and do not return to the project area until October. It is prudent to complete construction in bald eagle nesting areas during non-nesting periods. If construction activities must be completed during nesting and rearing months, the U.S. Fish and Wildlife Service has guidelines and recommendations that will be followed (USFWS 2006).

According to The USFWS National Bald Eagle Management Guidelines, the proposed action would fall under "Category A," which includes construction of roads, trails, canals, power lines, and other linear activities, and alteration of shorelines or wetlands. Table 1 provides the guidelines for activities in Category A..

Table 1. Closest distances activities in Category A should be conducted relative to the location of a bald eagle nest.

Visibility	**If there is no similar activity within 1 mile of the nest**	**If there is similar activity closer than 1 mile from the nest**
If the activity will be visible from	660 feet. Landscape buffers are recommended	660 feet, or as close as existing tolerated activity for similar scope.

the nest		Landscape buffers are recommended.
If the activity will not be visible from the nest	330 feet. Clearing, external construction, and landscaping between 330 feet and 660 feet should be done outside breeding season.	330 feet, or as close as existing tolerated activity of similar scope. Clearing, external construction, and landscaping within 660 feet should be done outside breeding season

Source, USFWS, 2007.

<u>Effects of Diversion Operation on Bald Eagles</u>

Diversion canal operation is expected to decrease salinity in the Maurepas Swamp, which should have positive effects on Bald Eagles. Watts et al. (2006) found that population growth, nesting density and productivity of Bald Eagles was negatively correlated with salinity in Chesapeake Bay. One reason for the correlation between decreased eagle productivity and salinity may be the long term effects of saltwater intrusion on forest health and nest tree survival. Some nesting territories on the southern and eastern shores of Lake Maurepas, where salinity and baldcypress mortality are highest, may be completely deforested in less than a decade if current trends continue (Shaffer et al. 2003). The size and health of the Bald Eagle population in Maurepas Swamp depends on the population of suitable nest trees (Stouffer et al. 2005). Suitable snags may be utilized but they will eventually fall during large storm events. Therefore, it is essential that salinity be reduced to produce replacement nest trees to maintain the Bald Eagle population in Maurepas Swamp. In addition, a reduction in salinity may increase the populations of preferred, freshwater forage fish, thus increasing Bald Eagle population growth rates and breeding density (Stouffer et al. 2005).

Diversion of Mississippi River water into Maurepas Swamp may expose Bald Eagles to elevated levels of several aquatic contaminants including metals, polycyclic aromatic hydrocarbons, pesticides, herbicides, and volatile organic compounds (Stouffer et al. 2005). A screening-level risk assessment for Bald Eagles suggested there is a low magnitude risk associated with diverting Mississippi River water into Maurepas Swamp based on maximum concentrations of Mercury, Nickel, and DDX (Battelle 2005). Mercury concentrations in fish sampled from Lake Maurepas were lower than those from the Mississippi River, so Bald Eagles should not be at greater risk of exposure from a diversion of water into the swamp (Battelle 2005). In addition, Bald Eagles have been observed flying out of Maurepas Swamp to foraging sites along the Mississippi River. This suggests that some resident Bald Eagles will not experience increased risk of exposure to environmental contaminants from diversion operation.

5.5 Wading Bird Colonies

Effects of Diversion Construction on Wading Birds

Diversion construction is not expected to negatively impact any active nesting wading bird colonies.

Effects of Diversion Operation on Wading Birds

Diversion operation is expected to increase primary productivity of the Maurepas Swamp ecosystem (Stouffer et al. 2005). This should benefit wading bird populations by restoring diminishing suitable swamp forest habitat and increasing abundance of forage fish and crayfish in the affected area. Increased food availability should increase the carrying capacity of wading birds within the Maurepas Swamp.

However, the deeply flooded area near the diversion outfall will be unavailable for foraging for most wading birds during diversion operation. Fortunately, most wading birds are able to disperse many miles to alternative foraging areas and can return during periods of diversion inactivity. The abundance and availability of foraging habitat and prey items for wading birds in the constructed diversion canal will depend on the velocity and turbidity of the water. It is expected that foraging habitat and prey availability will be at a maximum when the diversion is operated at low flow volume.

Diversion operation is expected to increase the productivity of herbaceous vegetation in the interior swamp. This may eventually result in increased elevation and could reduce the amount of area with standing water in Maurepas Swamp for foraging wading birds (Stouffer et al. 2005). In the short-term, increased vegetation may reduce foraging habitat for wading birds that utilize open, interior sites. These negative impacts should be offset by increased food availability and nesting sites.

Wading bird colonies are frequently situated over water, which provides protection against predation. Therefore, increased flooding may generate more suitable nesting habitat in Maurepas Swamp.

Chemical contaminants in water diverted into Maurepas Swamp from the Mississippi River are of concern to higher-order predators that may bioaccumulate these toxins. Eggshell thinning and nest success of common wading bird species in Maurepas Swamp do not appear to be significantly affected by contaminants (Stouffer et al. 2005). This may be due to the fact that most of these species, except the Great Blue Heron, forage upon smaller fish than top avian predators. However, Great Blue Heron populations should not be negatively affected by high toxin concentrations as they appear to be lower in the Mississippi River than in the Maurepas Swamp (Battelle 2005).

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United States Department of the Interior

FISH AND WILDLIFE SERVICE
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July 7, 2010

Colonel Alvin B. Lee
District Engineer
U.S. Army Corps of Engineers
Post Office Box 60267
New Orleans, Louisiana 70160-0267

Dear Colonel Lee:

Please reference the letter and attached Biological Assessment (BA) dated May 21, 2010, sent by Mr. Richard Boe, Acting, Chief of your Environmental Branch requesting our concurrence with your determination of effects of the proposed Small Diversion at Convent/Blind River to the endangered pallid sturgeon (*Scaphirynchus albus*). You have determined that the project is likely to adversely affect this species. The Fish and Wildlife Services (Service) comments are provided in accordance with Section 7 of the Endangered Species Act (87 stat. 884 as amended; 16 U.S.C. 1531 et seq.).

The proposed project involves the construction of a small sized (up to 5,000 cubic feet per second [cfs]) freshwater diversion located at approximately River Mile (RM) 163 near Romeville, Louisiana for the purpose of restoring freshwater flow into a portion of the Maurepas Basin. The proposed operating plan has not been fully developed. Informal consultation between the US Army Corps of Engineers (Corps) and the Service has been ongoing since 2008; however, no coordination has been conducted for the proposed project.

According to your BA pallid sturgeon are known to be relatively abundant in the vicinity of the proposed diversion. Furthermore, recent sampling has confirmed at least one pallid sturgeon has been entrained in the Davis Pond Freshwater Diversion (RM 118). The Corps concluded that the Small Diversion at Convent/Blind River is likely (i.e., has the potential) to adversely affect the pallid sturgeon. Considering the above information and the information on the swimming ability of sturgeon presented in the BA, the Service concurs with the Corps' conclusion.

In order to ensure compliance with the Endangered Species Act, and to ensure the Service has sufficient information required to initiate formal consultation the following information will be required:

1) The distance and velocity of flow fields extending from the structure into the river should be determined, if feasible. This determination should be done at the proposed discharges (and various structure openings to achieve those discharges) to determine

potential entrainment throughout the diversion's operation. A comparison of those flow fields with the swimming capabilities of sturgeon should be conducted.

2) Data gathered at existing diversions by the Service's Baton Rouge Fish and Wildlife Conservation Office and by Nicholls State University was not examined within the BA. That information should be provided in a format (including plat showing locations) so that the timing and location of sampling efforts and of any sturgeon captured and their movements can be examined in detail. The size of sturgeon captured should also be provided.

3) Sampling data from the Mississippi River should be provided in a format (including plat showing locations) so that the timing and location of sampling efforts and of any sturgeon captured can be examined in detail. The size of sturgeon captured should also be provided.

4) Catch per unit effort for each sampling gear and stage of growth (e.g., juvenile, sub-adult, etc.) should be provided.

5) Calculate the average area of opening for the structure for flows of 500 cfs and 3,000 cfs as would vary with river stages throughout the year and an estimate of the number of days the structure will be at those areas based on the river's hydrograph.

6) Compare the above calculated (Number 5) average area of opening throughout the year with the Mississippi River channels cross sectional area at proposed diversions location.

7) Compare main channel flow (cfs) to water diverted (cfs) to calculate percent of latitudinal flow diverted.

8) Provide a final copy of the Scope-of-Work (SOW) that details sampling design, techniques, and calculation of catch-per-unit-effort.

9) A detailed and current description of the proposed project (e.g., operational plan) including a plat depicting the precise location and dimensions and a cross-section showing the bottom elevations of the structure and outfall channel.

10) Provide a review of larval fish studies in the Lower Mississippi River that are applicable, and relate that information to the potential impact the diversion may have on larval sturgeon.

11) Investigate potential features to be incorporated into the intake structure that would reduce the chance of entrainment or improve the likelihood of sturgeon being able to swim out of the structure and outfall channel.

12) The relative abundance of pallid sturgeon compared to the shovelnose sturgeon and other fish species in the Lower Mississippi River. The relative abundance should be presented by sampling gear type and by stage of growth (e.g., juvenile, sub-adult, etc.).

The formal consultation process for the project will not begin until we receive the above information, or a statement explaining why that information cannot be made available. We will confirm our receipt of that information; our notification letter to you will also outline the dates within which formal consultation on the proposed action should be complete and our biological opinion delivered.

Section 7 of the ESA allows the Service up to 90 calendar days to conclude formal consultation with your agency and an additional 45 calendar days to prepare our biological opinion. As a reminder, the ESA requires that after initiation of formal consultation the Federal action agency may not make any irreversible or irretrievable commitment of resources that limits future options. This practice insures agency actions do not preclude the formulation or implementation of reasonable and prudent alternatives that avoid jeopardizing the continued existence of endangered and threatened species or destroying or modifying their critical habitats.

If you have any questions or concerns about this consultation or the consultation process in general, please feel free to contact David Walther of this office at 337/291-3122.

Sincerely,

James F. Boggs
Supervisor
Louisiana Field Office

cc: FWS, Ecological Services, Jackson, MS
FWS, Fish and Wildlife Resource Office, Baton Rouge, LA
ERDC, Vicksburg, MS
LDWF, Natural Heritage Program, Baton Rouge, LA
OPCR, Baton Rouge, LA

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United States Department of the Interior

FISH AND WILDLIFE SERVICE
646 Cajundome Blvd.
Suite 400
Lafayette, Louisiana 70506

July 16, 2010

Colonel Alvin B. Lee
District Engineer
U.S. Army Corps of Engineers
Post office Box 60267
New Orleans, LA 70160-0267

Dear Colonel Lee:

This letter acknowledges the U.S. Fish and Wildlife Service's (Service) July 14, 2010, receipt of your agency's July 14, 2010, letter requesting initiation of formal Section 7 consultation under the Endangered Species Act (Act) of 1973 (87 Stat. 884, as amended; 16 U.S.C. 1531 et seq.). That letter provided additional project and species information necessary to initiate consultation. The consultation concerns the effects of the proposed Louisiana Coastal Area, Small Diversion at Convent/Blind River, project. In the May 21, 2010, letter and attached Biological Assessment (BA), the Service received initial project and species information concerning potential impacts to the endangered sturgeon (*Scaphirynchus albus*). We responded via a July 7, 2010, letter indicating the need to initiation consultation and requesting additional information. All information required of you to initiate consultation was included with your agency's letters or is accessible for our consideration and reference.

Section 7 allows the Service up to 90 calendar days to conclude formal consultation with your agency and an additional 45 calendar days to prepare our biological opinion (unless we mutually agree to an extension). Therefore, we expect to provide you with our biological opinion no later than October 13, 2010. However, we recognize that the legislatively mandated study schedule (i.e., study completion within three years from authorization) was developed to respond to the significant and ongoing rapid loss of coastal wetlands, therefore, we remain committed to working closely with the Corps to meet those deadlines and ensure that the authorization of coastal restoration projects is achieved.

We appreciate the cooperation and coordination of your staff during the past several months. If you have any questions or concerns about this consultation or the consultation process in general, please contact Jennifer Hogue (337/291-3144) or David Walther (337/291-3122) of this office.

Sincerely,

James F. Boggs
Supervisor
Louisiana Field Office

cc: LDWF, Natural Heritage Program, Baton Rouge, LA
FWS, Ecological Services, Jackson, MS

United States Department of the Interior

FISH AND WILDLIFE SERVICE
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Lafayette, Louisiana 70506

September 23, 2010

Colonel Edward R. Fleming
District Commander
U.S. Army Corps of Engineers
Post office Box 60267
New Orleans, LA 70160-0267

Dear Colonel Fleming:

This document is the Fish and Wildlife Service's (Service) biological opinion based on our review of the New Orleans District Corps of Engineers' (Corps), proposed Small Diversion at Convent/Blind River located in St. John the Baptist, St. James, and Ascension Parishes, Louisiana, and its effects on the endangered pallid sturgeon (*Scaphirhynchus albus*) per section 7 of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 et seq.). Your May 21, 2010, request for formal consultation was received on May 21, 2010. Additional information necessary to initiate consultation was provided by letter dated July 7, 2010.

This biological opinion is based on information provided in the May 21, 2010, biological assessment (BA), the July 14, 2010, letter providing supplemental information, the subsequent telephone conversation of August 27, 2010, regarding reasonable and prudent measures and methods for estimation of take, e-mail between the Service and the Corps, and other sources of information. A complete administrative record of this consultation is on file at the Ecological Services office in Lafayette, Louisiana.

Consultation History

FWS Log No: 2010-F-2997
Date Started: May 21, 2010 **Ecosystem**: Lower Mississippi River
Action Agency: U.S. Corps of Engineers, New Orleans District
Project Title: Small Diversion at Convent/Blind River
County: St. John the Baptist, St. James, and Ascension Parishes

The Biological Assessment was sent to us by members of the Army Corps of Engineers (Corps) on May 21, 2010. They determined that the project described herein was "Likely to affect, but not adversely affect" the listed pallid sturgeon. The U.S. Fish and Wildlife Service did not concur with this initial determination due to lack of information provided in the Biological Assessment and because of the reported catches of entrained pallid sturgeon in other diversions. The letter of nonconcurrence was sent by the Service to the Corps on July 7, 2010.

A meeting was held by the Corps on July 8, 2010 to discuss the path forward on the consultation. A timeline was established to ensure any missing information could be indentified and acquired in a timely manner.

Additional information and request to initiate formal consultation on the Small Diversion at Convent/Blind River and the Medium Diversion at White Ditch and their possible affects on the pallid sturgeon was received on July 19, 2010. An email exchange between the Service and the Corps occurred on July 16, 2010 on three different methods that could be used to estimate take.

An email was sent out by the Service to members of the Corps on August 18, 2010 with a list of possible reasonable and prudent measures that could be incorporated to reduce possible take.

A follow-up conference call was held on August 27, 2010 with Thomas Parker, Jan Hoover and Jack Killgore to discuss minimization measures and methods for estimating take.

A conference call with Dr. Boyd Kynard was held Sept 7, 2010 to further discuss bypass systems and fish passage.

Table 1. Species and critical habitat evaluated for effects and those where the Service has concurred with a not likely to be adversely affected determination.

SPECIES or CRITICAL HABITAT*	PRESENT IN ACTION AREA	PRESENT IN ACTION AREA BUT NOT LIKELY TO BE ADVERSELY AFFECTED
Gulf Sturgeon	*Present*	*Concur*
West Indian Manatee	*Present*	*Concur*

**The above species and critical habitat not impacted by this action will not be discussed further in this biological opinion.*

BIOLOGICAL OPINION

DESCRIPTION OF PROPOSED ACTION

The Small Diversion at Convent/Blind River is located at Mississippi River Mile (Rmi) 163 in the Mississippi River Deltaic Plain in the Upper Lake Ponchartrain. The project area covers three parishes in Louisiana; St. John the Baptist, St. James, and Ascension Parishes. The Maraupas Swamp contains a large contiguous track of cypress tupelo trees and is used for hunting, fishing and other recreational activities. The swamp has been showing signs of stress and accretion rates are not high enough to overcome subsidence rates. The proposed project would restore a more natural hydrologic regime and should help restore sediment imputs and reduce salt stress on the trees via the restoration of Mississippi River water flow into the area.

The Small Diversion at Convent/Blind River would be capable of diverting up to 5,000 cfs through 3 gated culverts and into a three mile long channel. Channel features include five concrete drainage control structures, thirty new berm gaps approximately 500 feet wide, the widening of 160 existing berms and three culverts at the railroad/Highway 61 crossing.

The Small Diversion at Convent/Blind River would be located near the town of Romeville and would be capable of diverting up to 3,000 cfs diversion. It has six major components: a diversion structure, a transmission canal, control structures of various sizes, approximately 30 berm gaps, cross culverts at four locations along U.S. highway 61 and instrumentation to monitor and control the diversion flow rate and the water surface elevations in the diversion, transmission, and distribution system in the swamp. Only those features that are located within the vicinity of the diversion structure are described in detail below; the remaining features (i.e., berm gaps, culverts, and distribution system) while part of the project are primarily for conveyance and distribution of water to ensure ecological benefits and should not materially impact pallid sturgeon.

The diversion would consist of open channel that would divert freshwater from the Mississippi River, transfer it under the east levee through a box culvert, and discharge it into the transmission canal (See Appendix). The primary hydraulic elements of the project inlcude: 3 – 10' x 10' multi-cell cast-in-place reinforced concrete box culverts under the east levee and LA 44; 3 – 10'x10' cast iron sluice gates with motor operators on the culvert inlets and trash racks also near the culvert inlet. The trash rack will be considerably larger in total area than the culverts and will be sloped at a distance approximately 10 feet from the face of the culverts.

The inlet canal would cross the Mississippi River batture to the box culvert and the box culvert will extend under the levee and road (LA 44) and discharge into the transmission canal approximately 100 feet east of the road. Erosion protection will be provided as needed at locations with higher flow velocities and turbulence, such as at the Mississippi River bank, in the inlet canal entrance, at the box culvert entrance, and at the culvert outlet. The conceptual design shows the inlet channel from the Mississippi River a distance of approximately 300 feet, to be concrete lined. This lining is not to protect from inlet velocities caused by the diversion, but from the velocities of the Mississippi River which can range from 4 to 6 feet per second. Ancillary elements at the diversion culvert facility include a gate tower to raise the sluice gate operators and operator access above the Mississippi River flood stage, a steel sheet pile cut-off wall in the levee to reduce the potential for seepage and piping (loss of fines), and stop logs both upstream and downstream of the sluice gates to isolate them for maintenance. The diversion site will include an access driveway, a site road for access to the top of the levee, fence, drainage, lighting, a security system, and a control building.

The transmission canal will transfer the diverted water approximately three miles from the diversion to an existing drainage channel at the swamp's edge. The transmission canal will be designed with a 25 percent factor of safety for the flow rate to avoid overtopping the berms. This is in anticipation that as the Mississippi River stage varies, the diversion control system will not control the flow rate to the precise design value. For the 3,000 cfs diversion, the transmission canal will be designed for 3,750 cfs. The canal will be an earthen trapezoidal channel section, with a 155-foot wide bottom, 4:1 (H:V) side slopes, and a depth of approximately 12 feet, including a 2- foot freeboard. The top width will be approximately 250 feet. The hydraulic grade line will be above natural ground for most of the route. Therefore, embankments or berms with 12-foot wide tops will be constructed on both sides of the canal. The transmission canal alignment crosses the Canadian National Railroad (CN RR) and LA 3125, a local highway; both crossings will consist of 8 – 12' x 8' reinforced concrete box culverts.

The culvert is currently set at elevation 0 MSL and the top is at elevation 10 MSL so at the operating point of 11 MSL in the River the diversion will deliver 3000 cubic feet per second. The diversion gates are automatically adjusted to maintain the 3000 cubic feet per second with changing levels of the Mississippi River and changing downstream tidal conditions from Lake Maurepas. The diversion is planned to be operated continuously between March through October each year. The actually flow rate of the diversion will depend on numerous factors including tidal variations, swamp water requirements, local rainfall events, Mississippi River stage and other environmental elements.

The following table shows the calculated flow and culvert cross section area for the River stages below 11 feet MSL:

Blind River Diversion Culverts Flow -Stage Relationship

Stage in Mississippi River (feet)	Culvert Cross Section (sq. feet)	Discharge Flow Rate (cubic feet / sec.)	Velocity at Face of Culverts (Feet / Sec.)	Annual Average Percent Exceedence (%)
>11	For River stages greater than 11 the gates will be automatically controlled to limit flows to 3000 cubic feet per second			
11	300	3000	10	47
10	300	2900	9.7	49
9	270	2600	9.6	51
8	240	2300	9.6	56
7	210	1800	8.6	61
6	180	1300	7.2	68
5	150	1000	6.7	74
4	120	800	6.7	80
<4	For River stages less than 4, flows are negligible and depend on Lake Maurepas tidal variations.			

The diversion is planned to be operated continuously between March through October each year but the actually flow rate of the diversion will depend on numerous factors including tidal variations, swamp water requirements, local rainfall events, Mississippi River stage and other environmental elements.

STATUS OF THE SPECIES/CRITICAL HABITAT

Species Description

Pallid Sturgeon are a bottom-oriented, large river obligate fish inhabiting the Missouri and Mississippi Rivers from Montana to Louisiana (Kallemeyn 1983, USFWS 2007) and the Atchafalaya River (Reed and Ewing 1993, USFWS 2007). It was proposed for listing as an endangered species on August 30, 1989 (54 FR 35901-35904) and was listed as endangered on October 9, 1990 (55 FR 36641-36647). The reasons for listing were the apparent lack of recruitment for over 15 years, and the habitat threats existing at the time of listing. Destruction and alteration of habitats by human modification of the river system is believed to be the primary cause of declines in reproduction, growth, and survival of the pallid sturgeon; however, commercial harvest, and hybridization in parts of its range also affected the population. Critical habitat has not been proposed or designated for the pallid sturgeon. The Service conducted a 5-year review of this species' endangered status in 2007 and determined that no status change was needed at that time.

Life History

Taxonomy and Genetics

The pallid sturgeon, one of the largest fish found in the Missouri-Mississippi River drainage, grows to lengths of over 6 feet (ft) (1.8 meters [m]), can weigh in excess of 80 pounds (lbs) (36 kilograms [kg]), and can be described as having a flattened, shovel-shaped snout, a long, slender, and completely armored caudal peduncle, and lacking a spiracle (Smith 1979). Though pallid sturgeon could potentially grow very large, most historical and recent published catches report pallid sturgeon weights of up to 30 lbs (Paul Hartfield, per comm.). As with other sturgeon, the mouth is toothless, protrusible, and ventrally positioned under the snout. The skeletal structure is primarily cartilaginous (Gilbraith et al. 1988). Pallid sturgeon are similar in appearance to the more common and darker shovelnose sturgeon (*S. platyrhynchus*) prompting a Similarity of Appearance rule passed in 2010 (75 FR 53598-53606). Pflieger (1975) reported the principal features distinguishing pallid sturgeon from shovelnose sturgeon as the paucity of dermal ossifications on the belly, 24 or more anal fin rays, and 37 or more dorsal fin rays. Forbes and Richardson (1905) noted that pallid sturgeon contain 20 to 22 ribs while the shovelnose sturgeon has only 10 to 11 ribs. The air bladder was also noted as being relatively smaller in the pallid sturgeon. Those authors recorded differences between the pallid and shovelnose sturgeon in the number of ventral radials, relative depth of lateral scutes, orbital space size, proportional lengths of inner and outer barbels, mouth width, proportion of head width to head length, and proportion of head length to body length.

While these morphological differences are commonly used to distinguish pallid sturgeon from shovelnose sturgeon (Bailey and Cross 1954, Keenlyne et al. 1994) visual differences can sometimes be difficult to note because of geographic variation, allometric growth, and hybridization between shovelnose and pallid sturgeon. Genetic testing can be another tool to further identify individuals though this technology needs further development. Since the pallid sturgeon was listed in 1990, however, geneticists and ichthyologists have worked to refine testing procedures and develop the materials to definitively distinguish and identify these two fish species. The following briefly summarizes the results of the more recent studies.

Campton et al. (2000) concluded that mitochondrial DNA (mDNA) analyses provide the first molecular genetic evidence for distinguishing Scaphirhynchus species. The results of that study indicate significant reproductive isolation between pallid and shovelnose sturgeon in areas of natural sympatry.

McQuown et al. (2000) developed a microsatellite database for use in genetic studies of various sturgeon species, including *Scaphirhynchus.* With the use of microsatellites, they found a high degree of polymorphism within each species.

Tranah et al. (2001) conducted a study utilizing five nuclear DNA microsatellite loci to measure genetic variability within and among populations of pallid and shovelnose sturgeon at the northern and southern extremes of their sympatric ranges. Their results indicated that pallid and shovelnose sturgeon are genetically distinct at three sympatric locations. They also found evidence in the upper Missouri River (2 populations were genetically distinct from pallid sturgeon in the Atchafalaya River) suggesting that northern and southern pallid sturgeon populations are reproductively isolated. Furthermore, shovelnose sturgeons from the three populations were genetically indistinguishable and showed no population structure (Tranah et al. 2001). Tranah et al. (2001) also noted that sturgeon from the Atchafalaya River that were morphologically determined to be hybrids were genetically different from pallid sturgeon but were not statistically distinguishable from shovelnose sturgeon. However, Tranah (2001) states that morphologically intermediate Atchafalaya River sturgeon appeared to be genetically intermediate to pallid and shovelnose sturgeon, suggesting these individuals were possibly hybrids.

Simons et al. (2001) conducted a phylogenetic study of the genus *Scaphirhynchus.* They could not establish hierarchical relationships based on mtDNA that are consistent with morphological data; however, their results are consistent with the hypothesis of a low rate of evolution between *Scaphirhynchus* species, and reflect recent hybridization between shovelnose and pallid sturgeon. They state that such hybridization is probably due to habitat degradation, but provide no supporting information as to the specific mechanism or causes of hybridization between the two species.

USFWS (2007) summarized additional genetic information; the following three paragraphs present that survey. The presence of sturgeon that appear to be morphologically intermediate between pallid and shovelnose sturgeon, were presumed to represent pallid-shovelnose sturgeon hybrids (Keenlyne et al. 1994, Carlson et al. 1985) and spurred an effort to determine the genetic origins of these fish. Tranah et al. (2004) combined the data from Campton et al. (2000) and Tranah et al. (2001) and added 4 additional microsatellite loci to the data set to determine the genetic origins of 10 morphologically intermediate sturgeon collected from the Atchafalaya River. All fish were classified as pallid, shovelnose or hybrid sturgeon via the hybrid index method of Campton (1987). Results of Tranah et al. (2004) support earlier morphometric-based conclusions on the presences of hybrids (Keenlyne et al. 1994) suggesting intercrossing or gene flow between the two species is more pronounced in the middle Mississippi and Atchafalaya Rivers than elsewhere. Tranah et al. (2004) also suggested that while shovelnose and pallid sturgeon are distinct morphologically, they are undergoing hybridization in the lower Mississippi and Atchafalaya Rivers.

Morphometric data also may indicate hybridization in the lower Missouri River (Grady et al. 2001a; Grady et al. 2001b; Doyle and Starostka 2003) based on the presence of morphologically intermediate sturgeon. The extent to which these hybrids are going beyond the first generation (introgressive hybridization) is currently unknown. Tranah et al. (2004) suggest that female pallid sturgeon are mating with shovelnose sturgeon males and the hybrids are subsequently backcrossing with the more numerous shovelnose sturgeon. This finding should be treated as preliminary because a small number of fish classified morphologically as hybrids were examined. Allendorf et al. (2001) theorized that pallid and shovelnose sturgeon in the lower Mississippi River have not evolved reproductive isolation to the same degree as pallid and shovelnose sturgeon in the upper Missouri River and suggested there may be no pure pallid sturgeon in the lower Mississippi River because all sturgeon located in that reach comprise a hybrid swarm. Although microsatellite studies have provided evidence of hybridization between pallid and shovelnose sturgeon in the Missouri, Mississippi, and Atchafalaya Rivers (Tranah et al. 2001; Heist and Schrey 2006a and b, Schrey and Heist 2007), these and other studies (Ray et al. 2007) have also demonstrated that shovelnose and pallid sturgeon remain genetically distinct from each other in the Missouri, Mississippi, and Atchafalaya Rivers, and a third group, hybrids/intermediates, are present.

Recent studies (Murphy et al., 2007, Kuhajda et al. 2007) have shown that at least some proportion of morphological variation in pallid sturgeon is due to allometric growth and/or geographic variation which has been mistaken for hybridization. Hartfield and Kuhajda (2009) found that the morphological variation considered as evidence of hybridization has been present in Mississippi River pallid sturgeon population for more than a century. They also found that hybridization rates between pallid and shovelnose sturgeon have been overestimated based on character indices because they do not account for allometric growth or for natural variation within or between populations within each species (Hartfield and Kuhajda 2009).

More information is needed on the evolutionary dynamics of intermediate forms between pallid and shovelnose sturgeon to understand the role and effects of hybridization on the status of pallid sturgeon (USFWS 2007, Hartfield and Kuhajda 2009).

Age, Growth and Reproduction

Pallid sturgeon, like most sturgeon species, are considered long lived species with slow growth and low reproductive rates. Studying the reproduction of these species has been difficult and exact details continue to elude researchers. Some recent studies have made an effort to explore pallid sturgeon reproduction (Deloney et al. 2009); however, even basic parameters such as spawning locations, substrate preference, water temperature, or time of year have not been well documented yet. Much of what has been learned about pallid sturgeon reproduction has been from tracking sexually mature sturgeon and captures of larval sturgeon. Age, growth and possible spawning events of captured fish can be determined from cross-sections of pectoral fin rays and sexual maturity of adult fish can be determined from visual inspection or use of an endoscope.

Fogle (1963) estimated growth rates (using cross sections of pectoral fin rays from six pallid sturgeon from Lake Oahe in South Dakota) were relatively rapid during the first 4 years, but that growth decreased to approximately 2.8- in. (70 mm) per-year between ages 5 and 10. Carlson and Pflieger (1981) presented data (n=8) from the Missouri and Mississippi Rivers in Missouri that showed slightly slower growth than from pallid sturgeon in South Dakota. Keenlyne and Jenkins (1993) found that male pallid sturgeon from Louisiana, Missouri, and North Dakota showed rapid growth from age-5 to age-7. The rapid growth slowed once the fish reached sexual maturity.

In 1998, a 66-lb (30-kg), 63-in (160-cm), female pallid sturgeon captured from North Dakota was aged following mortality. Dennis Scarneccia, with the University of Idaho, used techniques developed for white sturgeon and estimated the age at over 50 years and possibly as high as 60 (USFWS 2002).

Killgore et al. (2007a), aged pallid sturgeon from the Middle and Lower Mississippi River and found that fish of the same age but from the Lower Mississippi River were of a smaller size. However, as fish grew older, the size difference between the fishes from those two river reaches appeared to be reduced. In the Lower Mississippi River, size at sexual maturity (9 years) for females was estimated to be approximately 26.8 inches (680 mm), while males were approximately 24.4 inches (620 mm) at sexual maturity (7 years). Growth rates for fish greater than 11 years were much less than younger fish.

Kallemeyn (1983) reported that male pallid sturgeon reach sexual maturity at 21- to 23- in (53.3 to 58.4 cm); however, size and age of females at sexual maturity were unknown at that time. Conte et al. (1988) indicated that females of most sturgeon in North America do not mature until 7 years of age and typically require several years for eggs to mature between spawnings. The age of sexual maturity and intervals between spawning were estimated for nine pallid sturgeon by recording what were interpreted to be spawning events from pectoral fin ray cross sections. Sexual maturity for males was estimated to be 7 to 9 years, with 2- to 3- year intervals between spawning years. Females were estimated to reach sexual maturity in 15 to 20 years, with 3- to 10- year intervals between spawning years (Keenlyne and Jenkins 1993). Time of sexual maturity and the age intervals between spawning years is likely to be influenced by available forage, environmental conditions and other factors (USFWS 1993), and thus, likely varies to some degree between river reaches.

It can be difficult to isolate the exact cues for spawning because certain environmental factors can not be isolated; though it has been widely hypothesized that increases in discharge, photoperiod, and increases in water temperature may be possible cues that trigger upstream spawning migrations. Berg (1981) published that shovelnose sturgeon spawning migrations occur in response to increased flows in June. Similarly, Bramblett (1996) stated that discharge and photoperiod may be important environmental cues for the timing of movements for both shovelnose and pallid sturgeon; though, direct links between discharge and pallid sturgeon reproductive physiology have not been fully substantiated (Deloney et al. 2009). It has also been hypothesized that increases in water temperature may cue migrations and spawning events because water temperature changes are more predictable and usually coincide with changes in discharge, changes in photoperiod, and time of year (Deloney et al. 2009). Bramblett (1996) found a typical pattern of movement for pallid sturgeon was to move upstream into the Yellowstone River and out of the Missouri River in the early spring during increasing discharge and photoperiod; reside in the Yellowstone River during high discharge; and to move downstream, back into the Missouri River during late summer; though pallid sturgeon generally move long distances and it is unclear whether this movement is for spawning.

Pallid sturgeon are thought to spawn in the spring or early summer. All sturgeon species are multiple spawners, and release their eggs at intervals. Time of spawning for pallid sturgeon has not been well-documented, but is believed to occur sometime between March and July, depending on location

(Forbes and Richardson 1905, Gilbraith et al. 1988; Keenlyne and Jenkins 1993). Sexually mature pallid sturgeon have been observed in the Yellowstone River in western North Dakota during late May and early June when water temperatures ranged from 60-65°F (15.5-18.5°C) (USFWS 2000). A male pallid sturgeon in the Missouri River near Williston, ND, was observed running milt in late May 1991 (USFWS 2000). Deloney et al. (2009) noted the recapture of two tagged female pallid sturgeon in 2007 in the lower Missouri River that had spawned out completely sometime between late April and mid-May near Sioux City, Iowa and Ponca State Park, Nebraska. Keenlyne and Jenkins (1993) estimate that spawning probably begins in March in the lower Mississippi and Atchafalaya Rivers; in late April or early May in the lower Missouri and middle Mississippi Rivers; and in late May or early June in the upper Missouri River. However, catches of one seven day and one nine day post-hatch larval sturgeons near Vicksburg, Mississippi on May 20 indicated that hatching occurred on the 13 and 11 of May (Snyder 1994 in Constant et al., 1997). Another larval sturgeon captured at White Castle, Louisiana was collected on the 15 of May (Zimpfer et al., 1988 in Constant et al., 1997). Other larval sturgeon recently captured between Greenville and Vicksburg, Mississippi indicate hatching occurred in early to mid-May (Paul Hartfield personal comment). Incubation time of spawned eggs can vary but usually lasts 3 to 5 days (Columbia Environmental Research Center 2008, Dean 2004). Because pallid sturgeon eggs are adhesive, the younger the larvae captured, the greater chance it was spawned near its site of capture. Based on these larval catches, that span almost twenty years, it is most probable that hatching occurs in early to late May in the Lower Mississippi River. More recently, the capture of *Scaphirhynchus* larvae and post-larvae in the Mississippi River during fall months, as well as spring, could be interpreted as an extended season or a second spawn in the lower latitudes of distribution (Paul Hartfield, USFWS, per. comm. 2006). Ongoing sampling efforts by ERDC (2010) documented young-of-year (< 56 days old) sturgeon throughout the entire summer. Tripp et al. (2009) documented female shovelnose sturgeon with ripe eggs and males that were milting and a single age-0 sturgeon in the fall.

The adhesive eggs are released in deep channels or rapids and are left unattended (Gilbraith et al. 1988). The larvae of *Scaphirhynchus* are pelagic, exhibiting swim-up and drift behavior immediately after hatching. Downstream drift of larval pallid sturgeon begins at day-0 at hatching and continues up to day-13, with a decline after day-8 (Kynard et al., 2002, 2005). Field studies of drift dynamics and behavior of larvae pallid sturgeon, conducted in a Missouri River side channel, suggested that they may drift 152 to 329 miles (mi) (245 to 530 kilometer [km]) depending on water velocity, during the first 11 days, and tend to become more benthic between days 11-17 (Braaten et al., 2008), suggesting that river distance and suitable habitat available below spawning areas may be important to survival of *Scaphirhynchus* larvae, and a key factor in recruitment success of river sturgeon.

Keenlyne et al. (1992) estimated fecundity for a female pallid sturgeon taken from the upper Missouri River. The authors found the mass of mature eggs weighed 69 oz (1,952 g), which represented 11.4 percent of total body weight. Total fecundity was estimated at 170,000 eggs for this female. Females may take up to 10 years between spawnings, depending on the quality and quantity of food available in their natural habitat (Keenlyne and Jenkins 1993). Therefore, fecundity of a female may vary considerably, with an individual female spawning only a few times during her normal life span (Duffy et al. 1996).

Gathering evidence of successful pallid sturgeon reproduction and recruitment has been difficult throughout the range of the species and captures have generally been low suggesting lack of reproduction or low recruitment. However, as knowledge of sturgeon spawning physiology has improved and the ability of sampling gear to detect larval sturgeon has improved, researchers have begun to capture increasing numbers of larval sturgeon in the Middle Mississippi River and the Lower Mississippi River (Herzog, pers. comm., Hartfield pers. comm., Killgore, pers. comm.) and in the Missouri River. In 1998, the Missouri Department of Conservation (MDC) collected a young-of-the-year pallid sturgeon at approximate river mile 49.5 south of Cape Girardeau in the middle Mississippi River (Petersen and Herzog 1999). Hesse and Mestl (1993) collected two sturgeon larvae from the Missouri River adjacent to Nebraska between 1983 and 1991. Those larvae were among 147,000 fish larvae collected during filtration of 18,340,014 cu ft (519,400 cu m) of river water. Gardner and Stewart (1987) collected no sturgeon larvae in 339 samples from the Missouri River, or in 77 samples from tributary streams, where 3,124 and 5,526 fish larvae were collected, respectively. During the summer of 1998 and 1999, several pallid sturgeon larvae were collected from the lower Missouri River in Missouri (USFWS 2000) suggesting that pallid sturgeon are reproducing in the Missouri River. In three years of sampling in/near Lisbon Chute on the Missouri River, the Service's Columbia Missouri Fishery Resources Office collected over 10,000 small fishes utilizing seines, benthic trawls and fyke nets. In processing 9,855 of these fishes, 1 confirmed and 2 probable larval pallid sturgeon have been identified (USFWS 2000). Similarly, Deloney et al. (2009) tracked gravid females in the Missouri River and made observations on their readiness. Subsequent recaptures showed they had spawned out in the Missouri river near the apex of their upstream migrations. Larval collections performed as part of the same study had several age-0 larval sturgeon collected below the confluence of Big Sioux River into the Missouri River in Northwest Iowa. It is not clear whether the larvae were pallid sturgeon or shovelnose.

As captures of larval sturgeon have increased so has evidence of recruitment. In the Middle Mississippi River, pallid captures aged from 5 – 14 years; in the Lower Mississippi River, pallid captures aged from 3 – 21 years (Killgore et al. 2007a). Comparing Lower Mississippi River age-growth curves (Killgore et al. 2007a) to capture length data in the Lower Mississippi River and Atchafalaya River indicate multiple cohorts spanning almost 20 years (3 to 20 years). Annual capture of larval pallid, along with limited age data from the Lower Mississippi River indicate some level of regular annual recruitment of pallid sturgeon in the Lower Mississippi River. Similarly, recent work in the Atchafalaya River has revealed fish of several age groups, suggesting that some reproduction and recruitment may also occur in the Atchafalaya River. The only physical evidence of reproduction, however, was three gravid females (Constant et al. 1997). According to their data, pallid sturgeon collected in the Atchafalaya River and other areas of the Mississippi River have averaged less than 6.6 lbs (3 kg) and length-at-age estimates calculated according to Fogle (1963) indicated that even the smallest fish were over age 6, with the oldest perhaps over age 14. The age of fish susceptible to the sampling gear used in their study indicates the most recent recruitment of pallid sturgeon was from the 1988 year class (Constant et al. 1997).

In 1985, a shovelnose larva was collected at White Castle (approximately 30 miles upstream; River Mile 193) (Constant et al. 1997). Larval shovelnose sturgeon have also been collected in the vicinity of Vicksburg, Mississippi (River Mile 435) approximately 144 miles upstream of the diversion

(Constant et al., 1997, Hartfield personnel comment 2009). Ongoing sampling efforts by ERDC documented YOY sturgeon between Rmi 80 and 160 over multiple years (ERDC 2010) with YOY sturgeon being captured as far south as Rmi 195.5. The size and location of some of those YOY would indicate a more southern spawning site (e.g., White Castle, Rmi 193) than previously believed. This area would likely represent the most southern location of larger gravel deposits within the river.

Feeding

Carlson et al. (1985) determined composition of food categories, by volume and frequency of occurrence, in the diet of shovelnose sturgeon (n=234), pallid sturgeon (n=9), and hybrids (n=9). Although benthic macroinvertebrates characteristic of river habitats are important dietary components (Modde and Schmulbach 1977, Carlson et al. 1985), the occurrence of lake and terrestrial invertebrates in sturgeon stomachs suggest that drifting invertebrates may also be important forage organisms (Modde and Schmulbach 1977, Constant et al. 1997). Aquatic invertebrates (principally the immature stages of insects) compose most of the diet of shovelnose sturgeon, while adult pallid sturgeon and purported hybrids consume a greater proportion of fishes (mostly cyprinids) (Hoover et al., 2007). Grohs et al (2009) reported that pallid sturgeon in the Missouri River downstream of Fort Randall Dam, had high percent occurrences' of Diptera, Emphemeroptera and fish and that percent composition of fishes increased with pallid sturgeon body size. It was noted that between ages four and five in their study, pallid sturgeon shifted from predominately invertebrates to fishes. Other researchers also reported a higher incidence of fishes in the diet of adult pallid sturgeon than in the diet of shovelnose sturgeon (Cross 1967, Held 1969). Most piscivorous Missouri River species eat large quantities of aquatic insect larvae in early life and even as adults (Modde and Schmulbach 1977).

Movement

Pallid sturgeon exhibit seasonal variation in movement patterns based upon temperature and discharge (Bramblett 1996, Constant et al. 1997, Sheehan et al. 1998, Hurley 1996). The timing of pallid sturgeon movements and migration in the Lower Mississippi River may differ from that of other rivers (i.e. the Missouri River) and other portions of the Mississippi River (Constant et al., 1997). Migrations and movement in the Atchafalaya River was associated with water temperatures between 14^0 and 21^0 Celsius (C) (Constant et al,. 1997) and spring and early summer season (Schramm and Dunn 2008). Movement patterns also vary between spawning versus non-spawning years (Bramblett 1996). Bramblett (1996) reported an average home range of 48.8 mi (78 km) in the Yellowstone and upper Missouri Rivers while Sheehan et al. (1998) reported a home range of 21.2 mi (34 km) in the middle Mississippi River. Sheehan et al. (1998) speculated that because habitat in the Mississippi River is relatively uniform, large movements and home ranges may not be as beneficial in the Mississippi River as in the Yellowstone and Upper Missouri Rivers area, because study fish are not likely to encounter new habitats and thus have a smaller home range.

As large river fish, pallid sturgeon are capable of moving long distances in search of favorable habitat. Sheehan et al. (1998) noted one study fish moving along a 60.3 mi (97 km) stretch of river. Bramblett (1996) noted a maximum home range as large as 198.6 mi (319 km), with pallid sturgeon moving up to 13 mi/day (21 km/day) and shovelnose sturgeon moving up to 9 mi/day (15 km/day). Schramm and Dunn (2008) documented one fish in the Atchafalaya River moving 96 mi. Dean (2007) reported the capture of a pallid sturgeon in the Atchafalaya River that was produced at the Blind Pony State Fish Hatchery in Missouri and released in 1997. Hoover et al. (2007) hypothesized that long-range movements during the spring may not just be associated with spawning but could also be associated with feeding.

Erickson (1992) found pallid sturgeon movement greater during the night while Bramblett (1996) observed greater movements during the day. The primary habitat difference suspected in those findings was turbidity. Erickson (1992) had secchi readings as high as 157 in. (400 cm) while Bramblett (1996) averaged 8 in (20 cm) and rarely exceeded 39 in (100 cm). Bramblett (1996) modeled the information from his study and found that predictive depth of pallid sturgeon was greater during the hours following sunrise and suggested that pallid sturgeon may be photophobic.

Hoover, et al. (2005) examined swimming performance of juvenile pallid sturgeon (maximum size 6.3 inches) at different velocities to determine possible entrainment by dredges. Minimum escape speeds for pallid sturgeon ranged from 1.6 to 1.7 feet per second (fps) and burst speeds were determined to range from 1.7 to 2.95 fps. Because they frequently failed to exhibit rheotaxis or orientation to the direction of flow (greater than 25 percent were non-swimmers); their ability to avoid entrainment based on swimming performance was determined to be relatively low. Adams (1999) also studied swim performance in juvenile pallid sturgeon. It was found that maximum sustained swimming speed was 0.328 fps and 0.82fps for their two groups of fish. The fish were found to transition to burst swimming speeds at 1.31 fps and 1.9 fps, respectively. White and Mefford (2002) examined swimming behavior and performance of shovelnose sturgeon ranging from 25.2 to 31.5 inches in length to aid in the design of a fish passage on the Yellowstone River. The ability of shovelnose sturgeon to navigate the length of the test flume was best (60 to 90 percent) over a smooth bottom followed by coarse sand, gravel and then cobble, but the small sample size and large variability precluded this from being a definitive conclusion. The greatest success at negotiating the flume was determined to occur between the range of 2 and 4 fps; however success at greater velocities, 6 fps, did occur. Failure to exhibit rheotaxis was also observed at velocities below 1.6 fps. Conversely, Adams et al. (1997) found all adult shovelnose to be positively rheotatic. Pallid sturgeon are believed to avoid areas that have no water velocity (Constant et al 1997) though Erickson (1992) observed individuals in low water velocities between .001 m/s to 0.3 m/s (DeLonay and Little 2002, cited in Quist 2004, Erickson 1992 cited in USFWS 2007, Backes et al., 1992, Constant et al. 1997). It's important to note that swim studies are often performed on hatchery fish or fish kept in tanks with low water velocity. Fish that are exercised and conditioned to higher water velocities can often sustain higher swim speeds (Boyd Kynard, personal comm. Sept 7, 2010).

Habitat use

The pallid sturgeon is adapted to the pre-development habitat conditions that historically existed in the Mississippi River and its tributaries. Those conditions can generally be described as large, free-flowing, warm water, turbid habitats with a diverse assemblage of physical attributes that were in a constant state of change (USFWS 1993; Mayden and Kuhajda 1997). Floodplains, backwaters, chutes, sloughs, islands, sandbars and main channel waters formed the large-river ecosystem that provided the macrohabitat requirements for all life stages of pallid sturgeon and other large-river fish. Within this range, pallid sturgeon tend to select main channel habitats (Sheehan et al., 1998, USFWS 2007) in the Mississippi River and main channel areas with islands or sand bars in the upper Missouri River (Bramblett 1996, USFWS 2007). Pallid sturgeon typically remain in close contact with the substrate as this area provides food and refuge (Forbes and Richardson 1905, Schmulbach et al. 1975, Kallemeyn 1983, and Gilbraith et al. 1988).

The historic floodplain habitat of the Missouri and Mississippi Rivers provided important functions for the native large-river fish. Floodplains were the major sources of organic matter, sediments, and woody debris for the main stem rivers when flood condition flows crested their banks. The transition zone between the vegetated floodplain and the main channel included habitats with varied depths described as chutes, sloughs, or side channels. The chutes or sloughs between the islands and shore were shallower and had less current than the main channel. These areas provided valuable diversity to the fish habitat, and probably served as nursery and feeding areas for many aquatic species (Funk and Robinson 1974). The still waters in this transition zone allowed organic matter accumulations; important to macroinvertebrate production an important food source for both pallid sturgeon and shovelnose sturgeon (Carlson et al. 1985; Gardner and Stewart 1987). Flood condition flows connected those important habitats and allowed fish from the main channel to utilize those habitat areas and to exploit available food sources.

Pallid sturgeon were found to be more specific and restrictive in macrohabitat selection than shovelnose sturgeon (Bramblett 1996). According to that study, pallid sturgeon used river reaches with sinuous channel patterns, and islands and alluvial bars which generally have more diversity of depths, current velocities, and substrates than do relatively straight channels without islands or alluvial bars. The diversity of channel features such as backwaters and side channels was also higher. The subclimax riparian vegetation seres in those areas are indicative of a dynamic river channel and riparian zone (Johnson 1993).

Pallid sturgeon has have shown some preference in their selection of microhabitats and captures in the Mississippi River have been associated with islands, sand bars, gravel bars, and dikes in both the main channel and in secondary channels (USFWS 2007). In telemetry studies of pallid sturgeon on the middle Mississippi River, Sheehan et al. (1998) found a positive selection for main channel-border and downstream island-tips and also for depositional areas between wingdams and deep holes off wingdam tips. Those positive selections seem to correlate well with Carlson et al. (1985). Sheehan et al. (1998) speculated that areas between wingdam areas and downstream island-tips may be used as velocity refugia and/or feeding stations. Study sturgeon were found most often in main channel habitat; however, they exhibited selection against that habitat type. Their occurrence in such habitat was not surprising, considering that the main channel comprised approximately 65 percent of the available habitat in the study reach (Sheehan et al. 1998). Hurley (1996) also found that pallid sturgeon were selecting downstream island tips although they were not abundant within the study area.

Carlson et al. (1985) captured both pallid sturgeon and shovelnose sturgeon in gear-sets along sandbars on the inside of riverbends, and in deeply scoured pools behind wing dams, indicating overlap of habitat-usage by the two species. Four of 11 pallids, however, were captured in gear-sets in swifter currents where shovelnose sturgeon were less numerous. Although pallid sturgeon and shovelnose sturgeon habitat use and movements are similar in certain aspects, important differences were noted by Bramblett (1996). Pallid sturgeon showed significant preferences during most times of the year for sandy substrates, particularly sand dunes, and avoided the gravel and cobble substrates preferred for spawning (Bramblett 1996). Constant et al. (1997) noted that pallid sturgeon spent considerable time associated with sand substrates. They noted that preference for sand substrates in low-slope areas suggests that pallid sturgeon use such areas as current refugia (e.g., use sand-wave troughs created as bed-material moves along the river bottom (Gordan et al. 1992)). Similarly, Shramm and Kuntz (2009) found that pallid sturgeon in the lower Mississippi River were associated with sand bar habitat and wing dikes, with sand bars preferred in spring and summer and island tips and wing dikes preferred in the fall and winter. The pallid sturgeon collected on the Yellowstone River in July 1991 by Watson and Stewart (1991) was over a bottom of mainly gravel and rock, which is the predominant substrate at that capture site. Reed and Ewing (1993) found sturgeon occurring in the man-made, rip-rap-lined outfall channels of the ORCC in Louisiana. Bramblett (1996) found that pallid sturgeon preferred sandy substrates, particularly sand dunes, and avoided substrates of gravel and cobble. In contrast, shovelnose sturgeon significantly preferred gravel and cobble substrates and avoided sand.

Constant et al. (1997) reporting on radio-tracked sturgeon, stated that they were most frequently found in low-slope areas and that such areas were used in proportion to their availability. No sturgeon were observed on extremely steep slopes. They found that sand made up over 80 percent of the substrate in low-slope areas where over 90 percent of pallid sturgeon were located. Constant et al. (1997) stated that the preference for sand substrates in low-slope areas suggest that pallid sturgeon use such areas as current refugia. Sand substrates were found to have lower invertebrate densities than substrates of silt-clay which were generally located on areas of steep slope which were exposed by swift currents. As such, it would have been energetically costly for pallid sturgeon to remain near those substrates for extended periods of time. Telemetry observations, however, showed 55 percent of sturgeon locations occurred within 32.8 feet (ft) (10 meters [m]) of steep slopes, suggesting that pallid sturgeon remained near areas of high food abundance (Constant et al. 1997).

Pallid sturgeon collected from the Missouri River above Garrison Reservoir in North Dakota during spring and fall seasons of 1988 to 1991 were found in deep pools at the downstream end of chutes and sandbars, and in the slower currents of near-shore areas. Those areas may have been providing good habitat for energy conservation and feeding (USFWS 1993). Sheehan et al. (1998) indicated that there were no shifts in habitat selection and avoidance by middle Mississippi River pallid sturgeon under three different discharge regimes (low, medium and high discharge ranges of 0 - 165 thousand cubic feet per second (Kcfs), 165 - 270 Kcfs and >270 Kcfs). Data collected by Constant et al. (1997) support prior observations that shovelnose sturgeon tolerate lower current velocities than pallid sturgeon (Carlson et al. 1985, Ruelle and Keenlyne 1994, Bramblett 1996). They (Constant et al. 1997) also found that pallid sturgeon catch-per-unit-effort (CPUE) declined following shutdown of the Old River Control Structure and that no pallid sturgeon were collected when velocity was reduced to zero, although shovelnose sturgeon CPUE was highest at this time. Pallid sturgeon are believed to avoid areas that have very little or no water velocity (DeLonay and Little 2002, Quist 2004, Erickson 1992, USFWS 2003) and leave areas that no longer have flows (Backes et al., 1992).

Turbidity levels where pallid sturgeon have been found in South Dakota range from 31.3 to 137.6 Nephelometric Turbidity Units (NTU) (Erickson 1992). Pallid sturgeon avoid areas without turbidity and current (Bailey and Cross 1954, Erickson 1992). That behavior contributes to the rationale for why pallid sturgeon are no longer found in the Missouri River reservoirs, and have not expanded into other rivers in the Mississippi drainage, even though access is available (Duffy et al. 1996).

Findings from a study on the Missouri River in South Dakota indicate that pallid sturgeon most frequently occupy river bottoms where velocity ranges from 0 to 2.40 feet per second (ft/s) (0 to 0.73 meters per second [m/s]) (Erickson 1992). Other studies in Montana found that pallids are most frequently associated with water velocities ranging from 1.51 to 3.15 ft/s (0.46 to 0.96 m/s) (Clancey 1990). Bramblett (1996) noted pallid sturgeon occupying bottom velocities ranging from 0 to 4.49 ft/s (0 to 1.37 m/s). Those velocities are commonly found throughout the species' range.

Pallid sturgeon were frequently found in water depths of 6.6 to 19.7 ft (2 to 6 m) in South Dakota (Erickson 1992). In Montana, pallid sturgeon were captured from depths between 3.9 and 12.1 ft (1.2 to 3.7 m) in the summer, but they were captured in deeper waters during winter (Clancey 1990). Other pallid sturgeon collected in the upper Missouri, Yellowstone, and Platte Rivers were captured in depths between 3.2 and 24.9 ft (1 to 7.6 m) (Watson and Stewart 1991, USFWS 1993). Bramblett (1996) found pallid sturgeon in depths from 2.0 to 47.6 ft (0.6 to 14.5 m), in contrast to Constant et al. (1997) who found pallid sturgeon at mean depths of 49.9 ft (15.2 m) and observed pallid sturgeon using depths of 23.0 and 68.9 ft (7 and 21 m) with greater frequency than the frequency of occurrence of those depths. The range of depth used by pallid sturgeon is likely related to the available habitat within the river segment (USFWS 2000). Because of the varying total depth of the rivers throughout its range the above depth information may have limited applicability to the Lower Mississippi River unless depth is expressed as a percent of the total river depth. The calculated percent of total river depth utilized by pallid sturgeon is approximately 70 (Bramblett 1996 cited in Constant et al., 1997, Constant et al., 1997). Using that percentage compared to water depths at the Bonnet Carre Spillway during the 2008 opening would indicate that pallid sturgeon should not be found on the batture in front of the structure during its operation. While the presence of *Scaphirhynchus* species on batture areas was previously reported (Hartfield personal comment), the usage of this habitat was never been quantified (incidental usage or actively used) and no records of river sturgeon use of the batture were known to be documented in literature, therefore, until the 2008 opening of the Bonnet Carre it was believed that batture usage by pallid sturgeon was incidental. Incomplete knowledge of the pallid's life history, especially in the Lower Mississippi River, does not preclude high water usage of the batture as a feeding habitat or velocity refugia.

Pallid sturgeon inhabit areas where the water temperature ranges from 32° - 86°F (0°C to 30°C), which is the range of water temperature on the Missouri and Mississippi Rivers. Sheehan et al. (1998) noted that sturgeon habitat use in the middle Mississippi River did not change with changes in temperature regimes and stated that temperature would not seem to have an affect on either habitat use or habitat selection by middle Mississippi River pallid sturgeon. Curtiss (1990) found no relation between surface water temperatures and depth used by shovelnose sturgeon on the Mississippi River, and no indication that shovelnose sturgeon were moving into deeper, cooler water (if available) as water temperature increased. Sheehan et al. (1990) found that swimming ability decreased and mortality increased for some river species below 39° Fahrenheit (F) (4°Celsius [C]). Hurley (1996) evaluated the habitat associations and movement of pallid sturgeon in the middle Mississippi River at water temperatures below 39°F (4°C), and above 39°F (4°C) yet below 50°F (10°C). Below 39°F (4°C), study sturgeon were found in association with current-disrupting habitat features such as downstream island-tips, wing dams, the main channel, and main channel border. Once winter temperatures rose above 39°F (4°C), habitat use became more restricted with main channel border and main channel comprising 87 percent of all relocations. When water temperatures rose to above 50°F (10°C) but below 68°F (20°C) during the spring, 40 percent of the contact relocations were in habitats between wing dams (Sheehan et al. 1990).

Population Dynamics

Much of the following information was taken from USFWS (2000, 2007). Because the pallid sturgeon was not recognized as a distinct species until 1905, it was not listed in early commercial fishery reports, so little is recorded about its abundance prior to that time. Even as late as the mid-1900s, it was common for pallid sturgeon to be tallied in commercial catch records as either shovelnose or lake sturgeon (Keenlyne 1995). Correspondence and notes of researchers suggest that the pallid sturgeon was still fairly common in many parts of the Mississippi and Missouri River systems as late as 1967 (Keenlyne 1989). The literature indicates that declines in populations have occurred coincidentally with development of the Missouri and Mississippi River systems for flood control and navigation (Deacon et al. 1979, Keenlyne 1989). Forbes and Richardson (1905) and Bailey and Cross (1954) indicated that the species was never as common as the shovelnose sturgeon and their abundance can sometimes be reported in terms of a ratio of pallid sturgeon caught to shovelnose sturgeon caught.

Table 1. Historical records of pallid sturgeon catches. Duffy et al 1996

Efforts to Collect Pallid Sturgeon and Numbers Collected by Decade and Location 1905-1994.			
DECADE	LOCATION	NUMBER OF EFFORTS	NUMBER OF PALLID REPORTED
1905-1954	**Mississippi River**	**3**	**15**
1954-1964	**Mississippi River**	**1**	**3**
	Lower Missouri River	1	3
	Upper Missouri River	15	210
1965-1974	**Mississippi River**	**1**	**1**
	Upper Missouri River	10+	354
1975-1984	**Mississippi River**	**1**	**6**
	Lower Missouri River	1	5
	Upper Missouri River	9	20+
1985-1994	**Mississippi River**	**1**	**1**
	Atchafalaya River	**2**	**25**
	Upper Missouri River	20	215
TOTAL	**Lower 4200 km**	11	59
	Upper 2000 km	54+	799+

Compiled from Duffy *et al.* 1996

During systematic sampling on the Missouri and Yellowstone Rivers in 1905, the Montana Department of Game, Fish and Parks collected 10 (2.2 percent) pallid sturgeon compared to 444 shovelnose sturgeon (Liebelt 1995). Reed and Ewing (1993) collected 11 (11 percent) pallid sturgeon, 18 purported hybrids and 74 shovelnose sturgeon in the vicinity of the ORCC in Louisiana. Between 1991 and 2007 over 3,000 river sturgeon were captured at the ORCC with over 600 individuals (greater than 20 %) being identified as pallid sturgeon (Dean 2007). In 2007, Watson and Stewart (1991) noted one (0.29 percent) pallid sturgeon out of 350 sturgeon from the lower Yellowstone River in Montana. Killgore et al., 2007b caught one pallid sturgeon for every six shovelnose in the Mississippi River between New Orleans (Rmi 100) and the Atchafalaya River (Rmi 319). Kirk et al., 2008, calculated a pallid to shovelnose ratio of 1:2.4 from sampling in the Mississippi River at approximately Rmi 146.

Bailey and Cross (1954) provided information based on their personal observations on the proportion of pallid sturgeon to shovelnose sturgeon from the Kansas River at Lawrence, Kansas (8 percent; number of specimens not reported), and the Missouri River in South Dakota, 3 of 62 specimens (5 percent). For the Mississippi River at New Orleans, 3 of 4 specimens (75 percent) were reported as being pallid sturgeon, however, these numbers are based upon specimens within collections, and therefore, those ratios may not reflect actual ratios within the river. Fisher (1962) recorded 4 of 13 river sturgeons (31 percent) from the Missouri River in Missouri as pallid sturgeon. Comparable commercial catch records are not available for the upper river reaches where commercial fishing was light or nonexistent.

Constant et al. (1997) noted that in surveys of commercial catch, shovelnose sturgeon accounted for between 52 percent and 98 percent of the total sturgeon catch, with the remainder composed of similar portions of hybrids (2 percent to 21 percent) and pallid sturgeon (0 percent to 26 percent). The higher percentage found by Constant et al., (1997) is comparable to the longer term percentage found by Dean (2007) who found that between 1991 and 2007 greater than 20 percent of over 3,000 river sturgeon captured at the ORCC were identified as pallid sturgeon. As previously mentioned Killgore et al., 2007b, found for every pallid sturgeon caught six shovelnose sturgeon were also caught in the Mississippi River between New Orleans (Rmi 100) and the Atchafalaya River (Rmi 319). A more recent survey performed by ERDC, caught one pallid and three shovelnose between Rmi 70 and Rmi 100.

Data for the Missouri River continue to indicate that wild pallid sturgeon in the upper Missouri River are large, mature, and likely old individuals, and provide little to no evidence supporting a naturally self-sustaining population. There appears to be no natural wild population surviving in the mid to lower Missouri River though some recent studies have had gravid females release eggs near Sioux City, Iowa and between Kansas City, Missouri and the confluence (Deloney et al. 2009). Sampling in the lower Missouri River to the confluence with the Mississippi River during the past decade continues to confirm a small population of wild pallid sturgeon in the lower Missouri River. Pallid populations in the Missouri River are being augmented with hatchery produced fish in order to ensure persistence of the species until threats are adequately addressed to promote a self sustaining population. Data collected after the Recovery Plan was developed indicate that pallid sturgeon numbers are higher in the Mississippi and Atchafalaya Rivers than initially documented in 1993. However, this increase in collections can be associated with increased sampling efforts and not quantified with catch-per-unit effort data. When this species was listed, there were only 28 recognized records of pallid sturgeon from the Mississippi River, with no recognized records from the Atchafalaya River.

Hatchery-reared Releases

In recent years, pallid sturgeon populations have been augmented by release of hatchery-reared fish. In 1994, the Missouri Department of Conservation (MDC) released approximately 7,000 fingerlings in the Missouri and Mississippi Rivers and an additional 3,000 fingerlings were stocked in 1997 (Graham 1997, 1999). Since stocking in 1994, approximately 86 pallid sturgeon returns have been reported, mostly in the Mississippi River downstream of St. Louis (Graham 1999). Thirty-five, 12- to 14-inch fish raised at Natchitoches NFH were stocked in the lower Mississippi River in 1998 (Kilpatrick 1999). In 2004, the Natchitoches NFH stocked approximately 3,500 fish in the Atchafalaya River and 6,500 were stocked in the Mississippi River (Dean, 2004). Also in 1998, 745 hatchery-reared yearling pallid sturgeon were released at three sites in the Missouri River above Fort Peck Reservoir (Gardner 1999) and another 750 yearling sturgeon were released near the confluence of the Yellowstone and Missouri Rivers (USFWS 2000).

Despite stocking efforts, pallid sturgeon remain rare compared to the shovelnose sturgeon. In 1997 and 1998, the MDC, Long Term Resource Monitoring Station at Cape Girardeau collected 7 pallid sturgeon (0.45 percent) compared to 1,549 shovelnose sturgeon in the middle Mississippi River

(Petersen 1999). All seven were hatchery-origin pallid sturgeon (USFWS 2000). Current data indicate that hatchery-reared pallid sturgeon are essential to preventing local extirpation in portions of the range in the upper Missouri River and have been used to reestablish pallid sturgeon in a small portion of the species' range in lower sections of the Missouri River. Deloney et al. (2009) had placed radio tags in 4 gravid females of hatchery origin and observed 3 of these tagged fish perform upstream migrations. Subsequent recaptures proved that they had released their eggs near the apex of these movements.

Status and Distribution

The historic distribution of pallid sturgeon as described by Bailey and Cross (1954) included the Missouri River, the Mississippi River from the mouth of the Missouri River to the Gulf of Mexico, and the lower reaches of the Platte, Kansas, and Yellowstone Rivers. Though a possible sighting of a pallid sturgeon has occurred as far south as the Head of Passes on the Mississippi River, it is unclear at what salinity level their southerly movements are curtailed. Records also indicated pallid sturgeon were present in the Mississippi River at Grafton, Illinois, (Forbes and Richardson 1905) and as far north as Keokuk, Iowa before that reach of the river was converted into a series of locks and dams for commercial navigation (Bailey and Cross 1954, Coker 1930). In 1992, this species was documented from the Atchafalaya River in central Louisiana (Reed and Ewing 1993, USFWS 2007). Today, pallid sturgeon remain scarce but are widely distributed throughout their range (Constant et al. 1997). No critical habitat has been designated for the pallid sturgeon at this time.

Distribution

Carlson and Pflieger (1981) stated that pallid sturgeon are rare but widely distributed in both the Missouri River, and in the Mississippi River downstream from the mouth of the Missouri River. A comparison of pallid sturgeon and shovelnose sturgeon catch records provides an indication of the rarity of pallid sturgeon. At the time of their original description, pallid sturgeon composed 1 in 500 river sturgeon captured in the Mississippi River at Grafton, Illinois (Forbes and Richardson 1905). Pallid sturgeon were more abundant in the lower Missouri River near West Alton, MO, representing one-fifth of the river sturgeon captured (Forbes and Richardson 1905). Carlson et al. (1985) captured 4,355 river sturgeon in 12 sampling stations on the Missouri River and Mississippi Rivers. Field identification revealed 11 (0.25 percent) pallid sturgeon. Grady (2001b) collected 4,435 river sturgeon in the lower 850 mi (1,367 km) of the Missouri River and 100 mi (161 km) of the middle Mississippi River from November 1997 to April 2000. Field identification revealed nine wild (0.20 percent) and nine hatchery-origin pallid sturgeon.

Today, pallid sturgeon, although variable in abundance, are ubiquitous throughout most of the free-flowing Mississippi River. When the pallid sturgeon was listed as endangered they were only occasionally reported from the following areas; from the Missouri River: (1) between the Marias River and Fort Peck Reservoir in Montana; (2) between Fort Peck Dam and Lake Sakakawea (near Williston, North Dakota); (3) within the lower 70 mi (113 km) of the Yellowstone River downstream of Fallon, Montana; (4) in the headwaters of Lake Sharpe in South Dakota; (5) near the mouth of the Platte River near Plattsmouth, Nebraska; and, (6) below river mile 218 to the mouth in the State of Missouri. Areas of most recent and frequent occurrence on the Mississippi River are: (7) near

Chester, Illinois; (8) Caruthersville, Missouri; and, (9) in the Atchafalaya River in Louisiana at the ORCC (USFWS 1993). Of 872 pallid sturgeon records prior to 1998, 70 percent were reported from the Missouri River; however, most historical collection efforts for the pallid sturgeon have been focused on the middle and upper Missouri River. Approximately 10 percent of the Missouri records were from below Gavins Point Dam; while the majority of records were from intensive sampling efforts in Montana, North and South Dakota, and include recaptures. In addition, 9 percent of the total records came from the Yellowstone River, 5 percent from the Mississippi River, 14 percent from the Atchafalaya River, and less than 2 percent from the St. Francis, Platte, Ohio, Kansas, and Yazoo Big Sunflower Rivers (USFWS 2000). The range of the pallid sturgeon has been split into 6 distinctive River Recovery and Priority Management Areas (RPMA). The status of pallid sturgeon in each RPMA is discussed below.

RPMA 1 (Upper Missouri)

RPMA 1 is defined in the pallid sturgeon recovery plan as the Missouri River from the headwaters of Fort Peck Reservoir upstream to the confluence of the Marias River, Montana (USFWS 1993). The status of wild pallid sturgeon in RPMA 1 has remained relatively unchanged since listing and continues to decline. According to data obtained from the National Pallid Sturgeon Database (USFWS 2006), a total of 52 wild pallid sturgeon (individual fish) has been collected in RPMA 1 during 15 years of sampling (1990-2005). The length frequency data suggests these are all adult fish. Current population estimates suggests that as few as 45 wild pallid sturgeon still remain in RPMA 1 (Bill Gardner, Montana Fish Wildlife and Parks (MFWP), pers. comm., 2005). There is an obvious absence of smaller sized wild pallid sturgeon despite utilization of sampling gear (gill nets, trammel nets, seines, and or trot-lines) capable of collecting smaller sized hatchery-reared pallid sturgeon. The size and age of surviving fish suggest that spawning, recruitment, or both, are severely limited or absent within this reach. However, the population is being supplemented with hatchery produced fish (USFWS 2006) in efforts to prevent local extirpation. Supplementation of RPMA 1 with hatchery produced pallid sturgeon has occurred sporadically since 1997, and is required to maintain the species within this RPMA. Based on recapture data from the National Pallid Sturgeon Database (USFWS 2006), pallid sturgeon from all stocking events have produced recaptures and are contributing to the current population structure.

RPMA 2 (Middle Missouri)

The Missouri River below Fort Peck Dam to the headwaters of Lake Sakakawea and the lower Yellowstone River up to the confluence of the Tongue River, Montana, is defined as RPMA 2. The wild pallid sturgeon population in RPMA 2 continues to decline. According to data compiled from the National Pallid Sturgeon Database (USFWS 2006), 527 wild pallid sturgeon captures occurred during 16 years of sampling (1990-2006). However, many of the adults were collected multiple times during those years. Removing recaptured pallid sturgeon from the query, indicates a total of 245 unique individual pallid sturgeon were collected during this timeframe. Available length frequency data indicate that these were essentially all adult fish. There is an obvious absence of smaller-sized wild pallid sturgeon despite utilization of sampling gear (gill nets, trammel nets, seines, and trot-lines) capable of collecting smaller sized pallid sturgeon. The size and associated age of surviving fish suggest that spawning, recruitment, or both are severely limited within this reach. However, the population is being supplemented with hatchery-reared fish to prevent local extirpation (USFWS 2006). Recent population estimates suggests that approximately 136 wild adult pallid sturgeon still remain in RPMA 2 (Klungle 2004). The length frequency data indicate that, up until the time supplementation began, all collected pallid sturgeon were adults except for one small fish collected in 1993. This suggests that, like RPMA 1, spawning, recruitment, or both are limiting viability within this reach. Supplementation of RPMA 2 with hatchery produced pallid sturgeon has occurred sporadically since 1998 with various numbers being stocked depending on hatchery success for any given year (USFWS 2006). To date, pallid sturgeon from all stocking events have produced recaptures and are contributing to the current population structure.

RPMA 3 (Lower Missouri River)

RPMA 3 is the Missouri River from 20 miles (mi) (32 kilometers (km)) upstream of the mouth of the Niobrara River to Lewis and Clark Lake. There is no native wild population of pallid sturgeon known to survive in RPMA 3 and the current population consists entirely of hatchery stocked fish. According to the National Pallid Database (USFWS 2006), the last record of a wild species from this area, that was not translocated, was the collection of a single pallid sturgeon circa 1991. Prior to this (1952-1991), there was a small number of wild pallid sturgeon collected from this area. Research within RPMA 3 during 1998 and 1999 (prior to stocking hatchery-reared pallid sturgeon in this reach) did not document a single pallid sturgeon, but numerous shovelnose sturgeon were collected. A total of 102 pallid sturgeon has been collected in RPMA 3 during 2 years of sampling (2003-2005). All of these were hatchery-reared with the exception of a few translocated wild pallid sturgeon. These data suggest that prior to supplementation, pallid sturgeon were extremely rare or extirpated in RPMA 3. Supplementation of RPMA 3 with hatchery-reared pallid sturgeon has occurred sporadically with various numbers being stocked depending on hatchery success for any given year. Recent work by Shuman et al. (2005) indicates that these stocked pallid sturgeon are surviving and growing (mean growth of age-6 and older fish was <0.06 mm/day (mm/d), mean growth for ages 2-4 was 0.238 mm/d, and the youngest year class (2004) grew 1.249 mm/d) in this reach with all stocked year classes (1997-1999 and 2001 and 2002) being collected in their samples.

RPMA 4 (Missouri to Mississippi River)

The Missouri River downstream of Gavins Point Dam, South Dakota to the Missouri River/Mississippi River confluence, including major tributaries such as the Platte River, defines RPMA 4. Although pallid sturgeon captures in RPMA 4 continue to increase with fishing effort, population levels and trends, habitat use, and movement patterns remain unknown. In the late 1990s, the USFWS Columbia Fishery Resources Office collected larval sturgeon in the Lisbon Chute on the Missouri River. Three were confirmed as larval pallid sturgeon and seven others were identified as probable pallid sturgeon (Krentz 2000) (identification by Darrel Snyder, Colorado State University Larval Fish Laboratory). Larval sturgeon (species not confirmed) also have been documented in the Missouri River below Gavins Point Dam by Nebraska Game and Parks Commission (NGPC) (Gerald Mestl, NGPC, pers. comm., 2005) and the Missouri Department of Conservation (MDC) (Herzog et al. 2005) and in the lower Platte River (Hofpar 1997, Reade 2000). Some of these smaller fish may have been pallid sturgeon, but accurately identifying these larval fish to species is difficult (Kuhajda et al. 2007). Recent studies also identify low numbers of unmarked pallid sturgeon (larger than fry) being collected from the lower Missouri River (Kennedy et al. 2006; Utrup et al. 2006). Augmentation with hatchery-reared pallid sturgeon has occurred sporadically since 1994 (USFWS 2006), and the collection of individuals from all stocked cohorts indicates that hatchery supplementation is contributing to the population (Barada and Steffensen 2006; Kennedy et al. 2006; Steffensen and Barada 2006; Utrup et al. 2006). Brood-stock collection for the hatchery propagation in 2009 produced 160 pallid sturgeon with 45 not known to be of hatchery origin were sent to the Blind Pony State Hatchery for evaluation; 16 of those fish were reproductively mature(Steffensen and Koch 2009). In 2010, pallid sturgeon were captured with 37 fish not suspected to be of hatchery origin were sent for evaluation, 19 were reproductively mature. Of a total 156 pallid sturgeon captured between 1999 and 2005, 51 are believed to be wild, 82 were of hatchery origin, and 24 were of unknown origin (Brannen and Wilhelm 2010). These fish were identified as wild if they did not possess a physical mark (i.e., coded wire tag or elastomere tag) indicating they were from a hatchery and were of a size class greater than what was associated with known hatchery-released fish. Fish labeled as hatchery origin had a distinguishing physical mark. Unknown individuals were consistent in length with known hatchery fish, but had no notable marks. These are considered unknown because certain marking techniques, like PIT tags, have been documented to fail. However, data within the National Pallid Sturgeon Database (USFWS 2006), for the period 1990-2005, notes 117 unique wild pallid sturgeon for RPMA 4. Available length frequency data for these fish indicates the majority to be adults. A few have been reported that are of sub-adult sizes (<600 mm), yet these sub-adult pallid sturgeon were all collected after supplementation commenced in 1994. Retrospective testing of the unmarked fish has revealed that 23 of the 24 unmarked pallid sturgeon were of hatchery origin, and the remaining unknown origin fish remained in that category because parental genetic samples were not available for all families released downstream of Gavins Point Dam and they could have originated from one of the unsampled families (DeHaan et al. 2008). The apparent lack of naturally produced or unknown origin pallid sturgeon in smaller size classes, coupled with higher relative abundances of hatchery origin pallid sturgeon and frequent captures of smaller size class shovelnose sturgeon, suggests that the sampling gear and effort being used are effective and that natural recruitment of pallid sturgeon is sporadic or limited in RPMA 4 (Barada and Steffensen 2006, Kennedy et al. 2006, Steffensen and Barada 2006, Utrup et al. 2006). These data also indicate that hatchery stocked fish are being collected and contributing to the population.

RPMA 5 (Mississippi River)

The Mississippi River from its confluence with the Missouri River to the Gulf of Mexico defines RPMA 5. While not identified in the Recovery Plan, the Mississippi River is often subdivided into two segments: the lower Mississippi River, extending 953 River miles (Rmi) (1,533.7 River kilometers (Rkm)) from the Gulf of Mexico to Cairo, Illinois; and the middle Mississippi River, extending 200 river miles (321.9 Rkm) from near Cairo, Illinois, to just above the mouth of the Missouri River confluence near St. Louis, Missouri. The availability of demographic data in RPMA 5 for pallid sturgeon has increased since the species was listed. Although pallid sturgeon captures in RPMA 5 continue to increase with fishing effort, population levels and trends, habitat use, and movement patterns remain unknown. Only 28 records of pallid sturgeon were recognized from the

Mississippi River when the species was listed in 1990 and the recovery plan was published in 1993 (USFWS 1993). During the past 6 years, over 300 pallid sturgeon (both sub-adult and adult size classes) have been collected from the Mississippi River. However, caution must be applied when looking at total catch because some of the collected pallid sturgeon reported by D. Herzog, (MDC) may also have been reported by Jack Killgore (U.S. Army Corps of Engineers (Corps) during their collaborative efforts. According to the National Pallid Sturgeon Database (USFWS 2006), 279 unique pallid sturgeon have been collected in RPMA 5 between 1990 and 2004. It is unclear what percentage of these may be hatchery origin pallid sturgeon with failed physical marks. Jack Killgore, Corps, (pers. comm., 2005) indicated that, between the winter of 2004 and the spring of 2005, 39% (7 of 18) of the pallid sturgeon sampled were hatchery stocked recaptures with a coded wire tag (CWT). Prior to 2004, pallid sturgeon were not checked for coded wire tags which were used to mark hatchery-reared pallid sturgeon stocked from Missouri's Blind Pony fish hatchery.

Middle Mississippi River

From 2002 through 2005, the Corps, Missouri Department of Conservation (MDC), and Southern Illinois University conducted a joint pallid sturgeon research project in the middle Mississippi River using trawling, gillnets, and trotlines as the primary sampling gears. A little over 64,000 hours of effort (combined for all gear types) was expended to catch a total of 148 pallid sturgeon as part of this project. Of the 148 pallid sturgeon collected, 12 individuals (8%) were hatchery origin fish determined by the presence of coded wire tags. This 8% is likely under representing the total number of hatchery origin fish in this sampling effort because scanning for coded wire tags was not a standard practice until 2004 (Jim Garvey, Southern Illinois University, pers. comm. 2006). Herzog et al. (2005) documented successful reproduction by the collection of larval pallid sturgeon in the middle Mississippi River, though the origin of these larval pallid sturgeon from within the middle Mississippi River is not known. Wild pallid sturgeon collected from this reach ranged between 500 and 1,000 mm fork length (FL; the length measured from the anterior most portion of the fish to the median caudal fin rays). Pallid sturgeon above 600 mm FL are believed to be of reproductive size, and the capture of small adult and sub-adult pallid sturgeon around and below this size may indicate that some level of recruitment is likely occurring in the middle Mississippi River or lower Missouri River, or could be a product of undetected marks in hatchery origin pallid sturgeon. Limited supplementation with hatchery reared pallid sturgeon has occurred in the middle Mississippi River (USFWS 2006).

Lower Mississippi River

ERDC sampled the lower Mississippi River (from the Chain of Rocks to south of New Orleans) from 2000 to 2006. During this time, 162 pallid sturgeon were collected from over 130 locations between Rmi 145 to 954 (Rkm 233 to 1535) (J. Killgore, Corps, pers. comm., 2005), with 3 recaptures. Sizes of pallid sturgeon collected range between 400 and 1,000 mm fork length (FL). This data set includes at least 30 "sub-adult" pallid sturgeon (i.e., <600 mm FL), showing some level of recruitment in the lower Mississippi River population. It is possible that recruitment of pallid sturgeon in RPMA 5 is higher than that reflected in sampling data. Over the past 3 years, monthly sampling in a 30 mile reach of the Lower Mississippi River (Rmi 580.9- Rmi 556.1) has resulted in the capture of over 60 pallid sturgeon, with a single recapture, and only 2 confirmed hatchery fish (Schramm and Kuntz 2010, Hartfield pers. comm. 2010). Although morphologically distinct pallid sturgeon as small as 450 mm FL are occasionally captured, some young-of-year and sub-adult pallid sturgeon may be misidentified as shovelnose or hybrids. One recent study found that character indices do not correctly identify small upper Missouri River hatchery-reared juvenile pallid sturgeon (<250 mm standard length; the length from the tip of the upper jaw to the posterior end of the vertebral column that is most commonly used in taxonomic studies) from shovelnose or hybrid sturgeon, or reliably separate larger pallid sturgeon (up to 600 mm standard length) from hybrid sturgeon (Kuhajda and Mayden 2001). Measurements taken from 48, 10-month old hatchery-reared juvenile pallid sturgeon (309 to 413 mm FL) spawned from Atchafalaya River stock and reared at the Natchitoches NFH, incorrectly identified all but two of these hatchery-reared pallid sturgeon as hybrids, and the two exceptions were incorrectly identified as shovelnose sturgeon (Jan Dean, USFWS, pers. comm., 2005). These juvenile fish were reared from morphologically distinct pallid sturgeon confirmed by genetic analysis. Murphy et al. (2007) also have found greater morphological variation in specimens of pallid and shovelnose sturgeon from the Mississippi River than what is accounted for in current identification indices. These studies suggest that at least some young-of-year, sub-adult, or small adult pallid sturgeon can be misidentified in the field as hybrid or shovelnose sturgeon. Captures of pallid sturgeon in the Mississippi River have been associated with islands, sand bars, gravel bars, and dikes, in both the main channel and in secondary channels.

RPMA 6 (Atchafalaya River)

RPMA 6 is the Atchafalaya River from the Old River Control Complex (ORCC) to the Gulf of Mexico. Collection data from this RPMA reflects an improvement in our understanding of the pallid sturgeon population trend. Prior to listing in 1990, pallid sturgeon had not been documented from the Atchafalaya River. In 1991, seven pallid sturgeon were collected from the Atchafalaya River near the ORCC, in Concordia Parish, Louisiana (Reed and Ewing 1993). A few years later (1993-95) an additional 106 pallid sturgeon captures were reported (Constant et al. 1997). Over approximately 600 individual pallid sturgeon have been collected from the Atchafalaya River since 1991 (Dean 2007). A conservative approach to species identification was used, based upon morphometric measurements, to identify pallid versus intermediate or "hybrid" sturgeon, and thus actual number of pallid sturgeon captured from the ORCC is likely underrepresented in these data. There have been at least 37 wild adult pallid sturgeon recaptures in the ORCC area since 1991, of which 32 have been during 2004-2006 (J. Dean, USFWS, pers. comm., 2006). The length distribution of pallid sturgeon captures has remained relatively consistent over the past 7 years, although the population appears to be comprised of predominantly adult pallid sturgeon >650 mm FL (Figure 12). However, gears used to sample this area are larger mesh and may not reliably sample sturgeon smaller than 400 mm. It is currently unknown if this consistent length frequency distribution through time combined with the occasional collection of smaller pallid sturgeon, results from local reproduction and recruitment, the passage of sub-adult and/or adult pallid sturgeon from the Mississippi River through the ORCC into the Atchafalaya River, or is simply a product of gear selectivity/bias. Gill net collections at the ORCC regularly capture shovelnose sturgeon between 400 and 750 mm FL. The pallid sturgeon are larger, measuring (with occasional exceptions) above 650 mm FL. It has been noted in the discussion under

RPMA 5, above, that there are difficulties in separating juvenile *Scaphirhynchus* to species. This also is true in RPMA 6. For example, trawl sampling for 2 days below ORCC during June 2005, resulted in the capture of six young-of-year *Scaphirhynchus* (196 to 410 mm total length (the length measured from the anterior most portion of the fish to the tip of the caudal fin rays). Three of these fish were marked indicating they were hatchery-reared juvenile pallid sturgeon released during fall and winter of 2004, and the other three had no physical mark and were considered wild young-of-year sturgeon. A character index was used on all six fish and misidentified the three hatchery-reared pallid sturgeon as hybrids, and identified two of the unknown wild sturgeon as shovelnose and the other as a hybrid (Jan Dean, USFWS, pers. comm., 2005). Further investigation is required to determine if allometric growth is resulting in the misidentification of some juvenile or sub-adult pallid sturgeon as shovelnose or "hybrids/intermediates", and to document local reproduction and recruitment in RPMA 6. Based on limited catch data reported by Constant et al. (1997), the ratio of hybrid to shovelnose sturgeon in the Mississippi River is similar to that in the Atchafalaya River.

The ORCC forms a potential uni-directional barrier to fish movement between the Mississippi and Atchafalaya Rivers. The structures associated with the ORCC likely could allow movement of fish from the Mississippi River into the Atchafalaya River, but could constitute a velocity barrier for movement in the opposite direction. Data exists to indicate that passage from the Mississippi River into the Atchafalaya Rivers does occur (Reed per comm. 2006, Hartfield in litt 2006, USFWS 2007). However, passage or lack of passage in the opposite direction has not been documented but sampling to detect such passage while increasing has probably not been sufficient to disprove such passage.

Habitat Destruction/Modification

Destruction and alteration of big-river ecologic functions and habitats once provided by the Missouri and Mississippi Rivers is believed to be the primary cause of declines in reproduction, growth, and survival of pallid sturgeon (USFWS 1993). The physical and chemical elements of channel morphology, flow regime, water temperature, sediment transport, turbidity, and nutrient inputs once functioned within the big-river ecosystem to provide habitat for pallid sturgeon and other native species. Human alterations such as, dams, levees, and channelization fragment the habitat and change the natural functions of the river reducing it's capacity to support the historic populations of large riverine fishes.

Construction and operation of dams on the upper Missouri River and modification of riverine habitat by channelization of the lower main stem Missouri and Mississippi Rivers has resulted in the curtailment of range and destruction or modification of habitat. On the main stem of the Missouri River (1,154 mi) (1,857 km) today, approximately 36 percent of riverine habitat within the pallid sturgeon's range has been transformed from river to lake by construction of six massive earthen dams by the Corps between 1926 and 1952 (USFWS 1993). The other 64 percent has been channelized, or altered due to dam operations (USFWS 1993). Most of the major tributaries of the Missouri and Mississippi Rivers have also been altered to various degrees by dams, water depletions, channelization, and riparian corridor modifications.

The upper ends of the reservoirs in the upper basin may be influencing the recruitment of larval sturgeon. Both the shovelnose and pallid sturgeon larvae have a propensity to drift after hatching (Kynard et al. 1998a, b). Migration routes to spawning sites on the lower Yellowstone River have been fragmented by low-head dams used for water supply intakes. Such habitat fragmentation has forced pallid sturgeon to spawn closer to reservoir habitats and has reduced the distance larval sturgeon can drift after hatching. Reservoir habitats may also place larval sturgeon at a greater risk of predation.

The channelized reach of the Missouri River downstream of Ponca, Nebraska, once a diverse assemblage of braided channels, sandbars, and backwaters, is now confined within a narrow channel of rather uniform width and swift current. Morris et al. (1968) found that channelization of the Missouri River reduced the surface area by approximately 67 percent. Funk and Robinson (1974) calculated that, following channelization, the length of the Missouri River between Rulo, Nebraska, and its mouth (~500 river miles) (310 km) had been reduced by 8 percent, and the water surface area had been reduced by 50 percent.

Missouri River aquatic habitat between and downstream of main stem dams has been altered by reductions in sediment and organic matter transport/deposition, flow modification, hypolimnetic releases, and narrowing of the river through channel degradation. Those activities have adversely impacted the natural river dynamics by reducing the diversity of bottom contours and substrates, slowing accumulation of organic matter, reducing overbank flooding, changing seasonal patterns, severing flows to backwater areas, and reducing turbidity and water temperature (Hesse 1987).

The pattern of flow velocity, volume, and timing of the pre-development rivers provided the essential life requirements of native large-river fishes like the pallid sturgeon and paddlefish. Hesse and Mestl (1993) found a significant relationship between the density of paddlefish larvae and two indices (timing and volume) of discharge from Fort Randall Dam. They concluded that when dam operations caused discharge to fluctuate widely during spring spawning, the density of drifting larvae was lower, and when annual runoff volume was highest, paddlefish larval density was highest. Hesse and Mestl (1987) also modeled these same two indices of discharge from Fort Randall Dam with an index of year-class strength. They demonstrated significant negative relationships between artificial flow fluctuations in the spring and poor year-class development for several native and introduced fish species including river carpsucker, shorthead redhorse, channel catfish, flathead catfish, sauger, smallmouth buffalo, and bigmouth buffalo. The sample size of sturgeon was too small to model in that study; however, a clear relationship existed between poor year-class development in most native species studied and the artificial hydrograph.

Levee construction along the lower Mississippi River, from the Ohio River to the Gulf, has eliminated major natural floodways and reduced the land area of the floodplain by more than 90 percent (Fremling et al. 1989). Fremling et al. (1989) also report that levee construction isolated many floodplain lakes and raised river banks. Bendway cutoffs to facilitate navigation have severed 15 meander loops between 1933 and 1942. These anthropogenic alterations (i.e., levee construction) effectively increased river stage and velocities at higher discharges by preventing overbank flows on the adjacent floodplains (Baker et al. 1991).

Free-flowing riverine conditions currently exist throughout the lower 2,000 mi (3,218 km) (60%) of the pallid sturgeon's historical range much of which is in the Mississippi River. The middle Mississippi River, from the mouth of the Missouri River to the mouth of the Ohio River, is principally channelized with few remaining secondary channels, sandbars, islands and abandoned channels and has been extensively diked. Navigation channels and flood control levees have reduced the size of the Mississippi Rivers floodplain there by 39 percent. However, recent studies and data from the Mississippi River (RPMA 5) suggests that riverine habitats are less degraded than previously believed, and that they continue to support diverse and productive aquatic communities, including pallid sturgeon. The 950 mile reach below the confluence of the Ohio River appears to be adequate for pallid sturgeon survival and recruitment and provides numerous complex secondary channel and island habitats known to be utilized by pallid sturgeon (P. Hartfield, per. comm.).

Commercial and Recreational Harvesting

Historically, pallid, shovelnose, and lake sturgeon were commercially harvested in all States on the Missouri and Mississippi Rivers (Helms 1974). The larger lake and pallid sturgeon were sought for their eggs which were sold as caviar, whereas shovelnose sturgeon were historically destroyed as bycatch. Commercial harvest of all sturgeon has declined substantially since record-keeping began in the late 1800s. Most commercial catch records for sturgeon have not differentiated between species and combined harvests as high as 430,889 lb (195,450 kg) were recorded in the Mississippi River in the early 1890s, but had declined to less than 20,061 lb (9,100 kg) by 1950 (Carlander 1954). Lower harvests reflected a decline in shovelnose sturgeon abundance since the early 1900s (Pflieger 1975).

Mortality of pallid sturgeon occurred as a result of illegal and incidental harvest from both sport and commercial fishing activities (USFWS 2000). Sturgeon species, in general, are highly vulnerable to impacts from fishing mortality due to unusual combinations of morphology, habits, and life history characteristics (Boreman 1997). Bettoli et al. (2008) conservatively estimated that 1.8% of the total sturgeon catch in Tennessee sturgeon caviar harvest were composed of pallid sturgeon. In addition, such illegal and incidental harvest may skew pallid sturgeon sex ratios such that hybridization with shovelnose is exacerbated. Killgore et al. (2007b) indicated that higher mortality rates for pallid sturgeon in the Middle Mississippi River could be attributed to incidental take by the commercial shovelnose fishery. In order to address incidental and illegal take of pallid sturgeon in caviar harvest, the Service has listed shovelnose as threatened, due to similarity of appearance to pallid sturgeon. The effects of this listing has effectively eliminated legal commercial harvest of sturgeon from river reaches where pallid sturgeon are known to occur.

Hybridization

Morphological variation between pallid sturgeon populations in the upper Missouri, lower Missouri, and Mississippi rivers has led to a hybridization debate. Upper Missouri River pallid sturgeon are characterized by large sizes in excess of 60 lb, and large pointed snouts, while pallid sturgeon from the lower Missouri, Mississippi, and Atchafalaya Rivers typically have shorter and rounder snouts and fish size rarely exceed 15 lb (6.8 kg) (Kuhajda and Mayden 2001, U.S. Fish and Wildlife Service 2007). Studies using mitochondrial DNA (Campton et al. 2000, Simons et al.

2001) and DNA microsatellite loci (Tranah et al. 2001, Schrey and Heist 2007, Ray et al. 2007) have demonstrated that genetic differences between shovelnose and pallid sturgeon occur throughout their sympatric range. However, several of these studies have also shown that genetic differentiation exists among pallid sturgeon from opposite ends of their range (Campton et al. 2000, Tranah et al. 2001) as well as between pallids inhabiting different geographic regions (upper Missouri, lower Missouri, Middle Mississippi, and Atchafalaya rivers) (Schrey and Heist 2007), and morphological variation within the pallid sturgeon range may be attributed to genetic structure of populations.

Bramblett (1996) found substantial differences in habitat use and movements between adult pallid and shovelnose sturgeon in less altered habitats in the Missouri River. Presumably, the loss of habitat diversity caused by human-induced environmental changes inhibits naturally occurring reproductive isolating mechanisms. Campton et al. (1995), and Sheehan et al. (1997) note that hybridization suggests that similar areas are currently being used by both species for spawning.

Carlson et al. (1985) studied morphological characteristics of 4,332 sturgeon from the Missouri and middle Mississippi Rivers. Of that group, they identified 11 pallid sturgeon and 12 pallid/shovelnose sturgeon hybrids. Suspected hybrids were observed in commercial fish catches on the lower Missouri and the middle and lower Mississippi Rivers (USFWS 2000). Bailey and Cross (1954) did not report hybrids, which may indicate that hybridization is a recent phenomenon resulting from environmental changes caused by human-induced reductions in habitat diversity and measurable changes in environmental variables such as turbidity, flow regimes, and substrate types (Carlson et al. 1985). A study by Keenlyne et al. (1994) concluded that hybridization may be occurring in half the river reaches within the range of pallid sturgeon and that hybrids may represent a high proportion of remaining sturgeon stocks. Keenlyne et al. (1994) noted few hybrids showing intermediacy in all characteristics as would be expected in a first generation cross, indicating the hybrids are fertile and reproducing. Hartfield and Kuhajda (2009) stated that hybridization rates in the Mississippi River have been overestimated, and there is no direct evidence linking the morphological or genetic variation defined as hybridization between pallid and shovelnose sturgeon in the lower Missouri, Mississippi, or Atchafalaya rivers with recent anthropogenic activities. However, if hybridization is a recent phenomenon precipitated by engineering of the Mississippi and Missouri river channels, it would present a threat to the survival of pallid sturgeon through genetic swamping if the hybrids are fertile, and through competition for limited habitat (Carlson et al. 1985).

Hubbs (1955) indicated that the frequency of natural hybridization in fish was a function of the environment, and the seriousness of the consequences of hybridization depends on hybrid viability. Hybridization can occur in fish if spawning habitat is limited, if many individuals of one potential parent species lives in proximity to a limited number of the other parent species, if spawning habitat is modified and rendered intermediate, if spawning seasons overlap, or where movement to reach suitable spawning habitat is limited (Hubbs 1955). Any of those conditions, or a combination of them, could be causing the apparent breakdown of isolating mechanisms that prevented hybridization between these species in the past (Keenlyne et al. 1994). Hartfield and Kuhajada (2009) examined three of the five original specimens used to describe the pallid sturgeon and found that the character indices currently used to distinguish the fish identify some of the type specimens as hybrids. They also noted purported hybrid reports were highest in the least altered habitats within the species range

(Lower Mississippi River), and lowest in the most severely altered areas (Upper and Lower Missouri River). In conclusion, they stated they found no evidence directly linking habitat modification and hybridization particularly in the Mississippi River and no evidence that hybridization constitutes an anthropogenic threat to the pallid sturgeon.

Microsatellite studies (Tranah et al. 2004; Heist and Schrey 2006a) have provided some genetic evidence for hybridization between pallid and shovelnose sturgeon in the Missouri, Mississippi, and Atchafalaya Rivers. However, it is currently unknown if all morphologically intermediate sturgeon are hybrids, if some hybridization is natural, or if hybridization is a result of habitat or other environmental changes. If these intermediates represent the effect of natural intercrossing between the monophyletic pallid sturgeon and shovelnose sturgeon due to anthropogenic influences, then intercrossing may indeed be perceived as a threat to the species. However, if genetically intermediate sturgeon are the result of sympatric speciation and a polyphyletic evolutionary origin of pallid sturgeon (e.g., as suggested by Campton et al. 2000 as a competing, alternative hypothesis), then intermediate fish could be considered a natural occurrence, the previously-identified mechanisms suggested for causing hybridization may not exist, intermediate sturgeon are a component of natural evolutionary processes, and hybridization does not pose a threat to the species.

Contaminants

Although more information is needed, pollution is also likely an exacerbating threat to the species over much of its range. Pollution of the Missouri River by organic wastes from towns, packing houses, and stockyards was evident by the early 1900s and continued to increase as populations grew and additional industries were established along the river. Due to the presence of a variety of pollutants, numerous fish-harvest and consumption advisories have been issued over the last decade or two from Kansas City, MO, to the confluence of the Mississippi River. That distance represents about 45 percent of the pallid sturgeon's total range. In 2000, the State of Mississippi formed a Fish Advisory Task Force to develop procedures regarding fish consumption advisories for organochlorine compounds and other contaminants. A review of USGS National Water Quality Assessment Program (NAWQA) data showed a persistence of elevated organochlorine levels and levels of DDT in fish tissue that are higher than other sampled parts of the Mississippi River study area. As a result, the state has issued its own preliminary advisories based on USEPA guidelines (USGS NAWQUA).

PCBs, cadmium, mercury, and selenium have been detected at elevated, but far below lethal, concentrations in tissue of three pallid sturgeon collected from the Missouri River in North Dakota and Nebraska. Detectable concentrations of chlordane, DDE, DDT, and dieldrin also were found (Ruelle and Keenlyne 1994). The prolonged egg maturation cycle of pallid sturgeon, combined with bioaccumulation of certain contaminants in eggs, could make contaminants a likely agent adversely affecting eggs and embryo, and development or survival of fry, thereby reducing reproductive success.

In examining the similarities and differences between shovelnose and pallid sturgeon, Ruelle and Keenlyne (1994) concluded that, while the shovelnose may not meet all the traits desired for a surrogate, it may be the best available for contaminant studies. Conzelmann et al. (1997) reported that trace element concentrations in Atchafalaya River shovelnose sturgeon were generally higher than in shovelnose sturgeon from other areas. Trace elements, many of which are essential for sustaining life, can adversely affect reproduction, development, and may ultimately be lethal if concentrations are excessive. Most trace element levels were unremarkable; however, cadmium, copper, lead, and selenium concentrations were elevated in ORCC samples and may warrant concern (Conzelmann et al. 1997).

Conzelmann et al. (1997) also reported that organochlorine pesticide (OC) concentrations are the main environmental concern in Louisiana's shovelnose sturgeon, and consequently, in the pallid sturgeon. Shovelnose OC concentrations were generally greater than were observed in fishes from other areas, and ORCC shovelnose sturgeon toxaphene levels were elevated compared to the National Contaminants Biomonitoring Program. Toxaphene possesses known carcinogenic, teratogenic, xenotoxic, and mutagenic properties; can cause suppression of the immune system; and may function as an endocrine system imitator, blocker, or disrupter (Colburn and Clements 1992). Those factors make toxaphene the greatest OC concern in ORCC shovelnose sturgeon and, by extension, the ORCC pallid sturgeon (Conzelmann et al. 1997). Further investigations are needed to identify contaminant sources in the Mississippi and Atchafalaya Rivers and to assess the role, if any, of contaminants in the decline of pallid sturgeon populations.

Entrainment

Another issue that is negatively impacting pallid sturgeon throughout its range is entrainment into water intake structures. The loss of pallid sturgeon associated with water intake structures has not been accurately quantified. The U.S. Environmental Protection Agency published final regulations on Cooling Water Intake Structures for Existing Facilities per requirements of Section 316(b) of the Clean Water Act. The rule making was divided into three phases. However, only Phase I and II appear applicable to inland facilities; Phase III applies to coastal and offshore cooling intake structures associated with coastal and offshore oil and gas extraction facilities. The following rule summaries are based on information found at the website <http://www.epa.gov/waterscience/316b/>. Phase I rules, completed in 2001, require permit holders to develop and implement techniques that will minimize impingement mortality and entrainment. Phase II, completed in 2004, covers existing power generation facilities that are designed to withdraw 50 million gallons per day or more with 25% of that water used for cooling purposes only. This rule, implemented through National Pollutant Discharge Elimination System permits, is intended to minimize negative affects associated with water cooling structures.

Section 316(b) of the Clean Water Act requires the U.S. Environmental Protection Agency to insure that aquatic organisms are protected from impingement or entrainment. As part of the Phase II ruling, some power plants have begun conducting required entrainment studies. Preliminary data on the Missouri River suggests that entrainment may be a serious threat that warrants more investigation. Initial results from work conducted by Mid-America at their Neal Smith power facilities found hatchery-reared pallid sturgeon were being entrained (Jordan in litt. 2006, Ledwin in litt. 2006, Williams in litt. 2006). Over a 5-month period, four known hatchery-reared pallid sturgeon have been entrained, of which two were released alive and two were found dead. Ongoing entrainment studies required by the Clean Water Act will provide more data on the effects of entrainment. However, addressing entrainment issues may not occur immediately and continued take of hatchery-reared or wild pallid sturgeon will limit the effectiveness of recovery efforts. In addition to cooling intake structures for power facilities, concerns have been raised regarding entrainment associated with dredge operations and irrigation diversions. Currently little data are available regarding the effects of dredge operations. However, the Corps' St. Louis District, and the Dredging Operations and Environmental Research Program have initiated work to assess dredge entrainment of fish species and the potential effects that these operations may have on larval and juvenile *Scaphirhynchus*. Data for escape speed, station-holding ability, rheotaxis and response to noise, and dredge flow fields are being used to develop a risk assessment model for entrainment of sturgeon by dredges. Entrainment has been documented in the irrigation canal supplied by Intake Dam on the Yellowstone River (Jaeger et al. 2004) (see also 2.3.1.5. Habitat or ecosystem conditions [e.g., amount, distribution, and suitability of the habitat or ecosystem]). Given that entrainment has been documented to occur in the few instances it has been studied, further evaluation of entrainment at other water withdrawal points is warranted across the pallid sturgeon's range to adequately evaluate this threat. Entrainment of pallid sturgeon stocked in the Mississippi River into the Atchafalaya River via the ORCC has been documented by the capture of a tagged stocked sturgeon that was released into the Mississippi River.

Biological Opinions which allow the take of a pallid sturgeon(s) also represent a factor that should be considered when examining factors that could have an influence on the pallid sturgeon population. The table below presents all completed Biological Opinions for the Lower Mississippi River.

OPINIONS[1] (yr/number)	**SPECIES**	**NUMBERS[2]**	**HABITAT[3]**	
			Critical Habitat	**Habitat**
2003 Log: 4-7-3-702	Biological Opinion on Natchitoches National Fish Hatchery's Collection of Endangered Pallid Sturgeon from Louisiana Waters for Propagation and Research	90 adults/season for 5 season (harassment) 8 adults/season for 5 seasons (death)	NA	NA
2004 Log: 4-7-04-734	Modification to **revise** 2003 IT estimates for BO (4-7-3-702) on Natchitoches National Fish Hatchery's Activities	120 adults/season for 5 season (harassment) 14 adults/season for 5 seasons (death)	NA	NA
2004 Log: 4-7-04-1456 (also 4-7-05-22)	Programmatic Biological Opinion Addressing Effects of the Southeast Region's Section 10(a)(1)(A) Permitting on the Pallid Sturgeon (5-	28 adults in captive propagation/year (death) 2,500 to 15,000 captive year-class 90 days old or older (one-time loss-death) 200 larval/juvenile/year sampling	NA	NA

	years)	(death) 3, 5-inch or greater fish/year netting (death or injury) 3 fish/year external tagging (death or injury) 1 fish/year transport (death) 5 fish/year radio-tracking (death or injury)		
2009 Log: 43440-2008-IE-3120,FA-43440-2009-FE-2777	Emergency Consultation for the operation of the Bonnet Carre Spillway and it's effects on entrained pallid sturgeon	14 Pallid sturgeon were captured in the spillway and incidental take occurred in the form of harassment. The Service estimated that a take of 92 pallid sturgeon occurred.	NA	NA

[1] Biological opinions within the action area.
[2] Incidental take permitted over 5-year period.
[3] No critical habitat has been designated for the pallid sturgeon.
[4] The original estimates for the 2003 BO are not included as they were revised in 2004.
[5] Incidental take of captive larval fish for NFH subsequently cover in the programmatic BO so is only counted once. NFH is no longer undertaking propagation.

Analysis of the species/critical habitat likely to be affected

The action under consideration is the construction and operation of the Small Diversion at Convent/Blind River This opening will allow Mississippi River waters to flow through the control structure and into an outfall channel leading to swamp. This will affect all life-stages of pallid sturgeon in the Mississippi River in the vicinity of the structure, because they could become entrained and it is not known if they are willing or able to move back through the structures to the river to complete essential life processes.

ENVIRONMENTAL BASELINE

Status of the species within the action area

The action under consultation occurs within the Lower Mississippi River area of RPMA 5. The range-wide status of the pallid sturgeon within the action area is discussed within the **Status and Distribution** section above. As noted in that section, Pallid sturgeon population size has not been quantitatively defined within the action area, however, collection efforts over the past decade show the species is widespread and not uncommon in the lower Mississippi River (LMR) from Rmi 954 to Rmi 100. Efforts to collect river sturgeon in the LMR have been relatively limited over the past decade, particularly considering the scope and scale of the available habitat. However, these collections have shown that pallid sturgeon occur throughout most of the 950 mile reach of the LMR

(Bettoli et al. 2008, Killgore et al. 2007a, Schramm and Mirick 2009, Hartfield, pers. obsv. 2001-2010), and the 200 mile reach of the Atchafalaya River (Constant et al. 1997, Herrala and Schramm 2010). Collections of pallid sturgeon in the LMR include over 200 individuals collected between the mouth of the Ohio River and Head of Passes (Killgore et al. 2007a; Hartfield, in litt. 2001-2010; Schramm and Kuntz 2010), ranging from 0 – 20 years of age (50 to >800 mm FL) (Killgore et al. 2007b, Hartfield pers. obsv. 2010). Over 600 pallid sturgeon ranging from 400 to >1000 mm FL have been collected from the Atchafalaya River distributary of the LMR (U.S. Fish and Wildlife Service 2007, Dean pers. comm. 2009).

Although pallid sturgeon population size in the LMR has not been quantified, available data suggest a substantial population when compared to fishing effort and fish species composition. Killgore et al. (2007a) found that pallid sturgeon comprised 2.2% of fish captured on winter set trotlines, and ranked 5th in frequency of capture out of 22 species collected. Recaptures of pallid sturgeon are also rare in the LMR. Killgore et al. (2007a) reported only 5 pallid sturgeon recaptures over 7 years. In another study that conducted 2 years of pallid sturgeon collection and telemetry efforts in a 30-mi reach of the Mississippi River, only a single pallid recapture occurred out of >60 pallid collected, even though telemetry results indicate most pallid sturgeon have remained within the sample reach (Schramm and Kuntz 2010).

There is also evidence that the LMR pallid sturgeon population can sustain removal of substantial numbers of individuals from the population. Bettoli et al. (2008) conservatively estimated that 2% of the commercially harvested sturgeon in the Tennessee reach of the LMR were pallid sturgeon (169 females over two seasons). Commercial harvest for sturgeon caviar has occurred annually in the Tennessee and Missouri reaches of the LMR for more than two decades. While baseline data on LMR pallid populations is lacking, the persistence of the species following more than two decades of harvest pressure on mature pallid sturgeon females, suggests the population is relatively robust. Additional evidence of population robustness has recently been noted in association with evidence of persistent and periodic entrainment losses of LMR pallid sturgeon. During an emergency opening of the Bonnet Carre Spillway during 2008, the Service estimated up to 92 pallid sturgeon were injured or killed due to entrainment. Bonnet Carre has been opened three times since the species was listed (1994, 1997, 2008). Other diversion structures that have been operating for one to five decades, are known (Old River Control Complex and Bonnet Carre) or suspected (Caernarvon and Davis Pond) to entrain pallid sturgeon. While episodes of commercial harvest or entrainment constitute substantial periodic or continuous localized loss of individuals to the pallid sturgeon population within the specific stream reaches, scientific collection efforts indicate the species is persisting within the commercially harvested and diversion reaches, and is not uncommon in the LMR (e.g., Killgore et al. 2007 a,b; Schramm and Kuntz 2010).

Factors affecting species environment within the action area

Historically, the section of the Mississippi River bordering the action area would have had many sand bars and side channels that would have been usable habitat for pallid sturgeon. This section of the river has been heavily modified for the purposes of navigation and has few of these natural features left. Contaminants in water, sediments, or prey species could float down river and be in the vicinity of the action area which could affect any pallid sturgeon present.

EFFECTS OF THE ACTION

This section includes an analysis of the direct and indirect, and its interrelated and interdependent activities effects of the proposed action on the species in the action area.

Factors to be considered

A stage discharge relationship for the Mississippi River at the diversion site could not be located and most likely is not available. Typical discharge rates for the Mississippi River at the time of maximum diversion (3000 cubic feet per second [cfs]) are in the range of 500,000 cfs therefore, the maximum diversion flow represents approximately 0.6 percent of the flow in the river. For the range of river stages from 4 to 11 feet, the river's cross section at the diversion point (River Mile 162) varies from 110,000 to 130,000 square feet. In general the cross section of the diversion culverts (300 square feet) is less than 0.25 percent of the Mississippi River's cross section. At a stage of 11 the river at it deepest point is 130 feet.

The diversion is planned to be operated continuously between March through October each year. The actually flow rate of the diversion will depend on numerous factors including tidal variations, swamp water requirements, local rainfall events, Mississippi River stage and other environmental elements. The maximum discharge is anticipated to occur approximately 53 percent of the time. Examination of discharge data for the Caernarvon Freshwater Diversion between 2001 and 2010 indicates that it discharges below its maximum capacity from approximately 73 to 90 percent of the time.

At a distance of 30 feet from the culvert entrance the diversion's velocity is approximately 2.5 fps. The velocity, however, through the culvert at maximum flow is approximately 10 fps and would occur approximately 53 percent of the time. After the flow passes through the culverts it enters a stilling basin that is part of the transmission canal. The transmission canal is a trapezoid earthen channel with typical velocities of 1.5 to 2.0 fps. The highest velocities would occur within the culverts, however, approximately 25 percent of the time velocities within the culverts are anticipated to be at or less than 6.7 fps; a speed at which sub-adults could potentially swim against. Velocities however, within the transmission canal could be slow enough that sturgeon could fail to exhibit rheotaxis (<1.6 fps) and swim down the transmission canal. Between 2002 and 2010 velocities within the Davis Pond Diversion Outfall Canal greater than 3 fps occurred less than 1 percent of the time. Nine of 12 tagged sturgeon released in that 11,000 feet long canal eventually ended up at the end of that canal in the ponding area. However, sporadic trips by sturgeon from the ponding area back into the outfall canal have been recorded with up to 4 months passing between such trips.

The floor of the culverts will be approximately level with both the inlet and transmission canal. Shovelnose and lake sturgeons have been documented to swim through the Upper Mississippi River locks and dams (Brooks, et al. 2009). Shovelnose sturgeon have been documented to swim over the Intake Diversion Dam on the Yellowstone River; the downstream side of this dam is basically a slope. Conversely, pallid sturgeon are not known to swim upstream over this structure. White and Meddford (2002) documented only 2 of 16 shovelnose sturgeon crossing over a 21-inch vertical baffle in velocities ranging from 0.8 to 4 fps.

Attempts to correlate spillway operation dates, duration or volumes of flow with the entrainment of lake sturgeon (*Acipenser fulvescens*) through the Little Long Generating Station Facilities were unsuccessful (Seyler et al., 1996), however, Adams et. al. (2007) utilized volumes to determine potential number of green sturgeon (*Acipenser medirostris*) entrained. Seyler et al., (1996) reported lake sturgeon undertaking post spawning downstream migrations are entrained through a spillway that diverts excess flows around the hydropower generating station. Annual recovery and relocation efforts were reported to be carried between 1990 and 1995. Recovery and relocation of green and white sturgeon has also been conducted at water diversions off the Sacramento River. Entrainment of more sturgeon was associated with higher flows; however uncertainty in the data has confounds any further data interpretation (USBRC 2008).

Analyses for effects of the action

Direct effects are those direct or immediate effects of a project on the species or its habitat. Indirect effects are those that are caused by or result from the proposed action, are later in time, and are reasonably certain to occur. Direct effects of the diversion are limited to the entrainment of all natant life stages of the pallid sturgeon. Indirect effects in the form harassment (i.e., affect breeding) would be associated with the future loss of progeny from sturgeon that could never return to the river to spawn. The diversions are not anticipated to adversely impact water quality or any habitat utilized by pallid sturgeon for spawning, nursery, or feeding in the Mississippi River. However, habitat conditions in the canals downstream of the diversions outflow canal would not be conducive (i.e., higher water temperatures, lower dissolved oxygen) to the long-term survival of larval and young-of-year (YOY) resulting in take via harm (i.e., mortality). It is not known how long sub-adult and adult sturgeon could survive in the outflow canals; tagged sturgeon within the Davis Pond Outfall Canal have survived close to 6 months. However, since no tagged sturgeon have successfully returned to the river it is anticipated that those sturgeon will remain entrained for the remained of their lives and would not contribute to the spawning population.

Effects of the action on larval, fry, and juvenile fish

No larval or YOY *Scaphirhynchus* were collected by Nichols State University (Schultz 2010) in the outfall areas of any diversion or freshwater siphon, however, the collection of larval sturgeon within any habitat typically requires considerable efforts which often only results in the capture of a few specimens (Quist 2004). Evidence of larval and YOY *Scaphirhynchus* usage of this river reach has been documented since 1985, with recent data collections indicating a greater abundance than previously thought (Constant et al. 1997, ERDC 2010; See also Age, Growth and Reproduction).

Kynard et al. (2002) and Braaten et al. (2008) reported long larval drift times. Pallid sturgeon larvae were determined to travel at approximately the mean river velocity for the first 11 days after hatching and then slightly slower for the next 6 days because of the sturgeon's transition to a benthic life stage. Distances covered during larval drift are affected by water velocity, however water temperature can affect larval/fry development rates (warmer temperatures increase development rates) which would also affect drift distances. Higher water velocities are experienced with larger flood events (U.S. Army Corps of Engineers 2009). Water velocities in the Mississippi River south of Baton Rouge (Rmi 231) have been documented to range from 4.4 fps to 1.5 fps depending on the discharge. South of Baton Rouge the river channel is larger and the slope of the river decreases, thus velocities are slower than those above Baton Rouge (Wells 1980). Surface water velocities measured north of Baton Rouge range from 2.9 fps to 5.6 fps for discharges of 200,000 cfs to 1million cfs, respectively. The Corps has computed surface water velocities of the Mississippi River at New Orleans (Rmi 107; approximately 56 mile downstream). For the highest mean monthly river stage at New Orleans the mean river velocity would be 6.1 fps at the surface and 5.4 feet per second at 60 percent of the rivers depth. If the most southern pallid sturgeon spawning sites are the previously hypothesized gravel bars located in the vicinity of Vicksburg (Rmi 435) approximately 272 miles upstream of the structure (Hartfield personal comment) and a mean water velocity of 5.4 fps (3.7 miles per hour) is assumed to occur from Vicksburg to the diversion, larvae could travel approximately 88 miles per day if entrainment into eddies, the batture and other areas is assumed not to occur and could reach the diversion within 3 days. Sturgeon spawning further downstream would be susceptible to entrainment at an even sooner time.

The recent capture of *Scaphirhynchus* larvae and post-larvae in the Mississippi River during fall months, as well as spring, could be interpreted as an extended season or a second spawn in the lower latitudes of distribution (Paul Hartfield, USFWS, per. comm. 2006). Ongoing sampling efforts by ERDC (2010) documented young-of-year (< 56 days old) sturgeon throughout the entire summer.

It is probable that larval and juvenile fish will encounter the flows of the diversion. The lack of any of those life stages being captured within in the outfall area of any existing diversion or siphon and the still relatively few records from within the river precludes even making a reasonable assumption as to the number of such sturgeon that would be likely to be entrained. Because of the believed inability of such small sturgeon to swim against velocities likely to be encountered within the culverts it is not likely that any of those size sturgeons could return to the river. Nor is it believed that all would survive the outfall areas where higher temperatures, lower dissolved oxygen levels and slow currents exist; survival within outfall canal may be possible as evidenced by the survival of older sturgeon in the Davis Pond ponding area, but the duration of the survival is unknown. Nonetheless, failure to capture any of these size sturgeons (using appropriate gear) indicates that any entrained may have been swept downstream from the immediate outfall or left the outfall areas as velocities decreased. Considering the above factors, the Service believes that an unquantifiable number of larval could possibly be entrained and possibly a greater number of juveniles but still not a significant number of either life stage. However, almost all of those life stages that would be entrained would probably experience mortality.

Effects of the action on sub-adult and adult

The Service caught, tagged with sonic tags and released 17 *Scaphirhynchus* in the Davis Pond Outfall Canal. Six stationary receivers were positioned along the outfall canal and one in the river to detect sturgeon movement and determine their ability to navigate back into the river. Of the tagged sturgeon, four are believed to have lost their tags, three are still within the outfall canal and nine are in the ponding area. Sturgeon have moved freely within the outfall canal and between the ponding area and canal with trips between the later two areas occurring over several months. It was anticipated that sturgeon might be able to swim back to the river at lower river stages. However, at the date of the last data collection the river stages had not decreased to levels that would have reduced the velocity through the structure sufficient to allow this to occur; monitoring is ongoing to provide additional data.

Sampling by ERDC (2010) found that the ten-mile river reach (Rmi 179 -160) where the diversion is located produced the second highest number of pallid sturgeon caught using trotlines and is equal in number to the next downstream reach with both producing the second highest number of sturgeon caught by all sampling gear combined. While sampling effort varied by 10-mile river reaches this reach had the second highest sampling effort of all gears combined. Sampling from July 2009 to June 2010 by Nicholls State University (Schultz 2010) in the Davis Pond Outfall Canal captured 3 shovelnose sturgeon and one pallid. The Davis Pond Freshwater Diversion can discharge up to 10,650 cfs, while the Convent/Blind River maximum design discharge is 3,000 cfs.

Sturgeon swimming burst speeds should allow them to swim against the velocities in the structure at lower river stages. Burst speeds, however, cannot be maintained for long distances and the length of the culvert is approximately 320 feet. Therefore, any sub-adult or adult sturgeon that are entrained may only have a very limited opportunity to swim against slower velocities and migrate back to the river, thus most sturgeon that are entrained may not be likely to return to the river.
It is believed that sturgeon located on the batture near the diversion entrance channel when it first opens or when flows are significantly increased would most likely be entrained. As additional fish move into the flooded batture while the structure is open, some of those could also be entrained. Emigration to downstream channels could occur as in-stream velocities decrease downstream of the structure.

With assistance from ERDC the Service utilized a hydrology-based method to determine the number of sturgeon entrained during the opening of the Bonnet Carre Spillway. The hydrology method is based upon a proposed relationship between the volume of water diverted and the number of sturgeon entrained. The hydrology methodology is similar to those recommended to determine entrainment by power plants (Goodyear 1997). However, methods proposed by Goodyear could not be used because insufficient information for some model parameters. While the method below is similar to that used to determine take for the Bonnet Carre opening, changes were made based more recent information and data obtained from the operating Davis Pond Freshwater Diversion. In the take determination for the Bonnet Carre the ratio of pallid to shovelnose in the river was utilized in the calculations. However, for this determination the ratio was taken from sturgeon captured in the operating diversion. While the ratios are fairly close (1.2 for the river and 1:4 for the diversion) the differences could possibly be explained by habitat usage and behavioral differences when sturgeon encounter areas of higher velocities. Use of pallid to shovelnose ratio to determine take was also previously utilized in the Final Biological Opinion for the Upper Mississippi River – Illinois Waterway System Navigation Feasibility Study (2004). The methodology currently utilized represents the Service's best efforts to determine entrainment, however, the Service recognizes that as more information about pallid sturgeon life history, behavior, and abundance becomes available these methods may need to be revised or totally replaced.

The Service based the effect of the action on sub-adult/adult pallid sturgeon on the following assumptions:

(1) All fish entrained will not return to the river;
(2) Adult pallid and adult shovelnose sturgeon will be entrained at the same approximate pallid to shovelnose ratio that has been found to occur in the Davis Pond Outfall Canal;
(3) With increases in the duration and volume of water diverted additional fish are entrained; entrainment is directly proportional to the duration or volume of diverted water;
(4) All tagged fish in the vicinity of sampling efforts had equal probability of being captured; and
(5) The percentage of tagged sturgeon captured of all tagged sturgeon available for capture in the Davis Pond Outfall Canal represents the effectiveness of sampling efforts (i.e., percent success) in determining the total number of sturgeon entrained.

The Service recognizes that the assumptions made may not be totally accurate for all sturgeon entrained but believes that this represents a scenario that is most likely to be the response of a majority of the sturgeon that will be entrained and therefore represents utilization of the best available information. Because the diversion is assumed to be operated at full capacity this estimate is conservative in terms of protecting the species by calculating a potential maximum number of entrained fish.

The Service calculated the maximum number of potentially entrained sub-adult/adult pallid sturgeon in the following manner: (1) From July 2009 to June 2010 there were 20 tagged sturgeon located in the Davis Pond Outfall Canal in the vicinity of sampling efforts being conducted by Nicholls State University on days that they sampled. During this time 2 tagged sturgeon were captured (i.e., 10 percent successful recapture rate) and 4 untagged sturgeon were captured with one being a pallid sturgeon (i.e., 25 percent):
(2) The ten percent successful recapture rate when applied to the 4 untagged sturgeon captured would estimate the number of entrained sturgeon to be 40 of which 25 percent are pallid sturgeon (i.e., 10 fish);
(3) The total discharge through the Davis Pond structure during the sampling period ($9.472\text{x } 10^{10}$ cubic feet [cf]) was divided by the estimated number of pallid entrained (i.e., 10) to determine the amount of volume discharged per each entrained fish ($9.472\text{x } 10^{9}$ cf);

($9.472\text{x } 10^{10}$ cf)/10 entrained pallid sturgeon = 1 pallid sturgeon entrained per $9.472\text{x } 10^{9}$ cf
and
(4) The proposed maximum discharge for each day was summed to determine the total volume of water diverted during one year of the structures operation (i.e., $6.32\text{x } 10^{10}$ cf). This total volume was divided by the volume of water discharged per each entrained fish ($9.472\text{x } 10^{9}$ cf) to calculate the possible maximum number of fish entrained (see below)

3,000 second-day-feet x 244 days x 86400 seconds per day = $6.32\text{x } 10^{10}$ cf diverted in 1 year

6.32x 10^{10} *cf /*9.472x 10^9 *cf = 6.68 fish per year (rounded to 7)*

Over the 50 year period of analysis that the Corps must examine project impacts and benefits it is estimated that approximately 350 pallid sturgeon would be entrained.

Lacking a population model or sufficient data to develop such a model the Service previously examined age frequency information for shovelnose and pallid sturgeons (Killgore et al., 2007, Morrow et al., 1998) to determine the likelihood that the 2008 Bonnet Carre opening jeopardized the continued existence of the pallid sturgeon. The following discussion presents that analysis to inform the assessment of this proposed project on pallid sturgeon. The analysis has been modified to present information from the Bonnet Carre opening as compared to the proposed discharge from the Convent/Blind River Diversion.

Bonnet Carré Comparison

While there are behavioral and biological differences in all life stages between the two species, similarities exist that would allow inferences of population effects to be made from shovelnose sturgeon age frequency tables and extrapolated to the pallid sturgeon population with appropriate caution. Age frequency tables produced by Morrow et al., (1998) and Killgore et al., (2007) for shovelnose and pallid sturgeon, respectively, combined cohorts of the same age over several years (3 years for shovelnose and 5 years for pallid) potentially masking any minor effects of the openings. However, examination of the range of cohorts that would be impacted by past diversions may be informative even though the small number of sturgeon in those cohorts may make such speculations tenuous. Cursory examination of age frequency by Killgore et al., (2007) did not show any differences in age class strengths for pallid sturgeon.

Gear selectivity (i.e., primarily trotlines) adds an additional complication to the use of age frequency tables to determine any possible effect of Spillway openings. Shovelnose sturgeon were fully vulnerable to trotlines at age 7, while pallid sturgeon were fully vulnerable at age 11 (Morrow, et al., 1998, Killgore et al., 2007). Therefore, estimates of sturgeon abundance or cohort strength below those ages would include that bias. In addition, the data for the shovelnose study (Morrow et al, 1998) was collected in the vicinity of Rosedale, MS (Rmi 585), but data for the pallid sturgeon study (Killgore et al, 2007) was collected from approximately New Orleans, LA, (Rmi 95) to the Chain of Rocks (Rmi 954). While long distant migrations for both sturgeon species has been documented (See Movement Section) the probability that sturgeon collected from these areas were likely to have encountered the previous openings of the Spillway is unknown. Because data for the two species were collected from two different time periods that did not overlap, the effect of each previous diversion could not be compared between the species.

Examination of the shovelnose cohort range that would have been spawned during the 1994 and 1979 openings does not contain a sufficient range in cohorts to make any determination of effect but does show some recruitment did occur (Table 2; see date below figure explanation). However, examination of the cohort that would have been effected by the 1983 operations appears to show a possible loss of a cohort. Without additional data or further investigation it is not known if this represents an actual loss of a year class and if the loss is a result of the operation of the structure coupled with the effects of the flood and other factors such as commercial harvesting that was allowed at that time or just a product of lower abundance of older age classes (Jack Killgore personal comment). The range of shovelnose cohorts that would have been approximately the same size during the 1983 operation as those entrained in the 2008 do not appear to be significantly reduced. Age classes subsequent to 1983 are well represented, including those that would include progeny of a 1983 cohort, indicating yearly recruitment occurred since 1983. Based on this limited information it appears possible that the 1983 opening could have effected the 1983 year class but overall any effect does not appear to have impacted future cohort abundance.

Table 2.

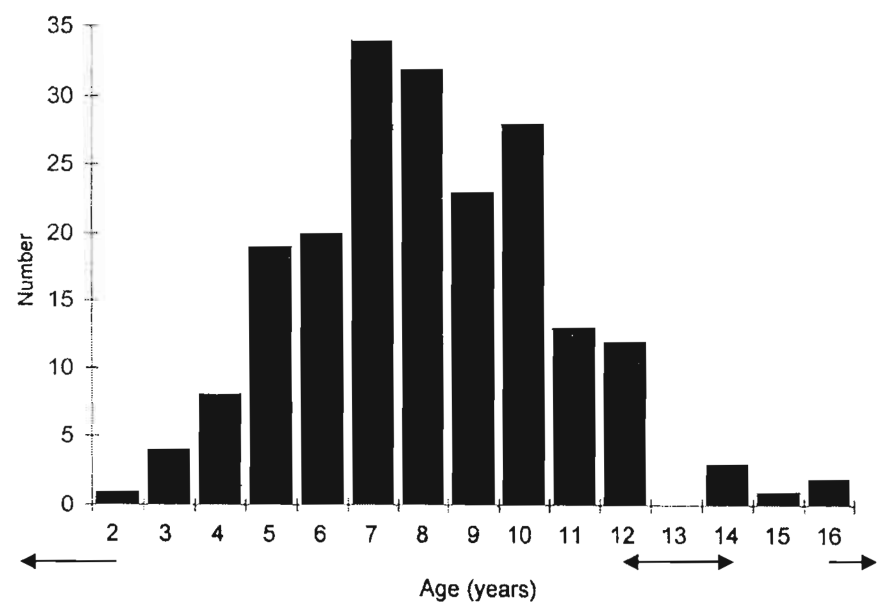

FIGURE 2.—Age frequency of 200 lower Mississippi River shovelnose sturgeon captured between 15 October 1995 and 12 March 1997.

Year of Opening 1994 1983 1979

The pallid sturgeon age distribution table (Table 3) has sufficient cohort ranges to examine the possible effects of the 1997, 1994, and 1983 openings. However, the examination was complicated by the longer sampling period which lengthens the number of years that cohorts could have been present during the diversion. Examination of years when spawned fish would have been present during the diversion does not present any discernable impact. As with the shovelnose data, the 1983 cohort range also includes a year that had no individuals captured, however, other cohorts in the same range do not show any discernable effect. Also like the shovelnose data, without additional data or further investigation it is not known if this represents an actual loss of a year class and if the loss is a result of the operation of the structure coupled with the effects of the flood and other factors or just a product of lower abundance of older age classes (Jack Killgore personal comment). Examination of cohorts that would have been of the size range of pallid sturgeon entrained in the 2008 (24 to 34 inches) opening did not show any discernable negative effect from the 1994 and 1997 openings. No sturgeon large enough to be present in the 1983 opening were captured; in addition, the slower growth rates of older sturgeon could complicate the use of that size fish for this type of analysis. Comparison of the 1997, 1994 and 1983 days of operation suggest that the 1983 operation could have extended into the shovelnose and pallid sturgeon spring spawning season which means that the river discharge and the operation of the Bonnet Carre could have impacted that cohort size. Because the 2008 opening was of a shorter duration and diverted less water (Table 4) than the 1997, 1994, and 1983 openings the Service believed that any impact from the opening would be similar but less than that of the 1997 operation. Examination of age distribution table does not show any discernable impact to the strength of any pallid sturgeon cohort from the 1997 opening. Furthermore, the age distribution of both species (Tables 5 and 6) indicates ongoing recruitment of juveniles and greater abundance (possibly survivorship) of all age classes but especially of spawning age individuals within the Lower Mississippi River (Table 3). While the cumulative discharge from the Convent/Blind River may exceed the Spillways discharge the Convent/Blind River discharge is based upon diverting the maximum flow every day. In addition, the small localized area of potential entrainment associated the diversions inlet canal (160 feet wide) when compared to the Bonnet Carre's approximately 7,700 wide opening could result in a much smaller chance of sturgeon encountering entraining flows. This coupled with the relatively few recaptures of tagged pallid sturgeon (indicative of a relatively large population) and the increased number of larval and juveniles being captured in the Lower Mississippi River leads the Service to believe that the proposed operation of the small diversion at Convent/Blind River is not likely to significantly affect the pallid sturgeon population.

Table 3.

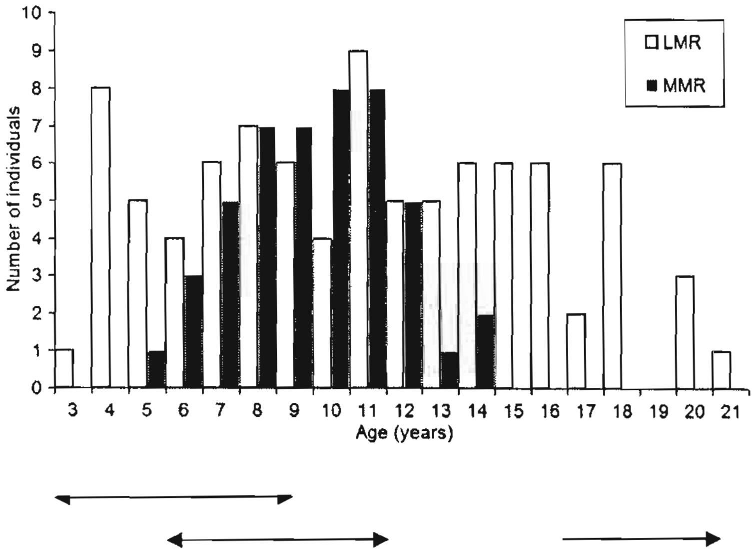

Fig. 1. Age distribution of pallid sturgeon in the lower Mississippi River (LMR) and middle Mississippi River (MMR)

Year 1997 1994 1983
of Opening

Table 4. BONNET CARRE SPILLWAY DISCHARGE COMPARED TO CONVENT/BLIND RIVER DIVERSION

YEAR	OPENED	CLOSED	DAYS OPERATED	TOTAL VOLUME CFS
1979	17 APR	31 MAY	45	$5.2099x10^8$
1983	20 MAY	23 JUN	35	$5.927x10^8$
1994	16 MAY	27 MAY	12	
1997	17 MAR	17 APR	31	$4.1221x10^8$
2008	11 APR	8 MAY	28	$2.6368x10^8$
CONVENT/BLIND RIVER	MARCH	OCT	244	$6.32x10^{10}$

Ongoing studies have demonstrated the greater abundance of pallid sturgeon within the southern portion of the Lower Mississippi River than in the more northern portions of its range. The ratio of pallid to shovelnose sturgeon from Rmi 179 to 80 ranges from 1:1 to 1:3 while a ratio of 1:22 has been tentatively calculated for Rmi 319 to 300 (ERDC 2010). Pallid sturgeon were the fifth most abundant fish based on sampling from the middle and lower Mississippi River (Killgore et. al, 2007). Recent data collected from the Lower Mississippi River indicates that they rank sixteenth in relative abundance (ERDC 2010).

Species' response to a proposed action
The Pallid Sturgeon Lower Basin Recovery Workgroup has identified information gaps essential to the consultation and recovery processes in the Lower Mississippi River Basin. These include: relative abundance of pallid sturgeon, demographics, feeding habits, habitat use, hybridization ratios, presence of fish diseases in the wild, population anomalies, and reliable separation and identification of pallid sturgeon, shovelnose sturgeon, and hybrids. A more recent information gap identified by the Lower Basin Work Group is the entrainment of adult and juvenile pallid sturgeon through the ORCC and potential entrainment through the existing coastal wetland restoration diversions. While recent publications have contributed to filling some of the former data gaps (e.g., Killgore et al., 2007, Hoover et al., 2007) incomplete knowledge of those areas remains. Therefore, the sturgeons' response to encountering the diversion flows (e.g., avoidance, actively sought) is unknown, which can affect the number of sturgeon believed to be adversely affected by the structures operation. There are several hypotheses on possible sturgeon reactions to entrainment that must be considered to determine project impacts: (1) only sturgeon located near the structure during its opening are subject to the possibility of entrainment(i.e., no increase in sturgeon entrained because of active avoidance); (2) sturgeon may actively swam into the structure seeking velocity refuge from main-channel flows and/or seeking food sources on the batture and/or in a perceived secondary channel (i.e., diversion); or (3) sturgeon are passively or actively entrained during down-river migration. It is likely that the reaction to a diversion would vary with the life stage of the sturgeon, and entrainment may be due to a combination of any of the above hypotheses.

As discussed previously, it is anticipated that approximately 7 pallid sturgeon per year will be lost from the population via entrainment through the diversion structure. In the context of larval, fry and juvenile fish, it is anticipated that an unspecified number of pallid sturgeon will be entrained and also lost from the population.

CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section, because they require separate consultation pursuant to section 7 of the Act.

No additional State, local, and private actions have been identified in addition to the ongoing threats previously described in the Status and Distribution sub-section of STATUS OF THE SPECIES/CRITICAL HABITAT. These human-caused threats include industrial development and associated intakes and discharges, electrical generating facility construction and associated intakes and outfalls, dredging for sand, incidental harvesting, and poaching. The indirect effects of those actions include loss of habitat and water quality degradation. Such activities are likely to continue throughout the action area.

Future major construction activities in the Missouri and Mississippi River basins, along with new point-sources of pollution discharge would presumably have a Federal nexus (for example, they require Federal funding or permitting) and their potential adverse effects to pallid sturgeon would require section 7 consultation under the Act. Major construction activities in the Lower Mississippi River could include several other proposed coastal restoration freshwater diversions south of Baton Rouge and the continued operation of the Bonnet Carre Spillway and the ORCC; however, because they would all have a Federal nexus they would also not be considered as cumulative effects as described in the previous paragraphs.

CONCLUSION

After reviewing the current status of the pallid sturgeon, the effects of the diversion and its cumulative effects, it is the Service's biological opinion that operation of that structure is not likely to jeopardize the continued existence of the species. No critical habitat has been designated for the pallid sturgeon; therefore, none will be affected.

INCIDENTAL TAKE STATEMENT

Section 9 of the Endangered Species Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act, provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

AMOUNT OR EXTENT OF TAKE ANTICIPATED

The following is a summary of the estimated incidental take previously discussed in the **Analysis for effects of the action** section. The Service believes incidental take in the form of harm (mortality associated with entrainment behind the structure) and harassment (loss of potential spawning adults) will result from the operation of the small diversion at Convent/Blind River. It includes.

The Service estimated incidental loss (by death or serious injury) associated with entrainment behind the structure of 7 pallid sturgeon (sub-adults and adults) per year with a total of 350 fish entrained over the life of the project. The Service anticipates the incidental take (direct death) of an unknown number of larval/juvenile pallid sturgeon due to entrainment but that number cannot be quantified. Indirect effects in the form harassment (i.e., affect breeding) would be associated with the future loss of progeny from sturgeon that could never return to the river to spawn. The diversions are not anticipated to adversely impact water quality or any habitat utilized by pallid sturgeon for spawning, nursery, or feeding in the Mississippi River. However, habitat conditions in the canals downstream of the diversions outflow canal would not be conducive (i.e., higher water temperatures, lower dissolved oxygen) to the long-term survival of larval and YOY resulting in take via harm (i.e., mortality) and it is anticipated that sub-adult and adult sturgeon will remain entrained for the remained of their lives and would not contribute to the spawning population.

EFFECT OF THE TAKE

In the accompanying biological opinion, the Service determined that this level of expected take is not likely to result in jeopardy to the pallid sturgeon.

REASONABLE AND PRUDENT MEASURES

The Service believes the following reasonable and prudent measures (RPMs) are necessary and appropriate to minimize the incidental take of pallid sturgeon by entrainment through the small diversion at Convent/Blind River.

1. Gate operations should minimize velocity through the structure by maximizing the open cross-section, especially at Mississippi River stages of 6 feet Mean Sea level or less (equates to velocities at the culvert face of 7.2 fps or less).
2. Any gate operation that would significantly increase or decrease the velocity (change greater than 500 cfs) should be implemented over several hours to allow fish sufficient time to migrate back to the river or swim away from the structure.
3. Once the end of the annual discharge period is reached minimal gate openings should be maintained for several days to allow passage of any sturgeon that may have emigrated downstream.
4. The downstream edge of the culverts should have a slope to act as a ramp and/or sufficient erosion protection that would prevent scour from forming a vertical ledge greater than 6 inches at the downstream end of the culvert.
5. In channel refuge consisting of several submerged wing dikes (or similar structures) on both banks should be constructed no further downstream than 75 feet from the structure. Minimal spacing between the structures should be 10 feet but can be moved to account for scour. The maximum suggested height is 24 inches, but the length extending into the channel is not yet determined.
6. The downstream side walls should be angled towards the culverts so they will guide fish back into the culverts at lower velocities.
7. The two outer most culverts should have fish passage baffles constructed on the floor of the culverts.

8. Monitoring to determine take and to reduce potential take by returning pallid sturgeon to the river should be undertaken

TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the Act, the Corps shall execute the following terms and conditions, which implement the RPMs described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

1. Manuals (or other similar documents) written to guide the daily operations and maintenance activities of the diversion should be written in cooperation with the Service. Any proposed changes to such document would require re-initiation of consultation under Section 7 of the ESA.
2. Detailed design of wing dikes and the scour protection to prevent development of a vertical ledge should be coordinated with the Service. After construction annual inspection (i.e., measurements) should be taken at the downstream edge of the culvert to determine need to for maintenance. If maintenance is required funding should be immediately requested.
3. Design of downstream side walls and detailed design of the fish passage baffles should be coordinated with the Service.
4. Three days of sampling effort will be made each quarter. Sampling will consist of at minimum utilizing otter trawls, gillnets (i.e., 27.4 meter by 1.8 meter, six mesh panel ranging from 23 to 76 centimeters), and trotlines (61 meters long with 60 dropper lines at 0.9 meter intervals using 2/0 hooks baited with worms). Up to eight trotlines will be fished on the bottom overnight and two gillnets will also be fish overnight. All procedures and protocols for handling sturgeon should be followed and are available at: www.fws.gov/mountain-praire/endspp/protocols/PallidSturgeonHandlingProtocol2008B.pdf

All pallid sturgeon captures should be measured and tagged according to the protocol; if permitted and when feasible, ageing and endoscopy to determine sex and reproductive stage should also be conducted. All pallid sturgeon captured should be returned to the Mississippi River as soon as practicable. The number and size of each pallid sturgeon caught by date and gear type should be provided to the Service. Unsuccessful sampling efforts should also be reported by date and gear type.

Upon locating a dead or injured pallid sturgeon that may have been harmed or destroyed as a direct or indirect result of the proposed project, the Corps and/or contractor shall be responsible for notifying the Service's Lafayette, Louisiana, Field Office (337/291-3100) and the LDWF's Natural Heritage Program (225/765-2821). Care shall be taken in handling an injured sturgeon to ensure effective treatment or disposition and in handling dead specimens to preserve biological materials in the best possible state for later analysis. Disposition of dead sturgeon is also addressed in the protocols.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

The Service has developed the following conservation recommendations to help minimize adverse effects and to development information that may further reduce adverse actions to the endangered pallid sturgeon.

1. Ongoing population studies for the Lower Mississippi River should be continued to aid the determination of future diversion impacts to the pallid sturgeon population.
2. A comprehensive review of fish passage literature should be undertaken to aid in the possible future design of additional fish passage features on other diversion projects.

REINITIATION NOTICE

This concludes formal consultation on the proposed action. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take (i.e., the habitat acreage amount described herein) is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take shall cease pending reinitiation.

The above findings and recommendations constitute the report of the Department of the Interior. If you have any questions about this biological opinion, please contact Ms. Jennifer Hogue of this office at 337/291-3144.

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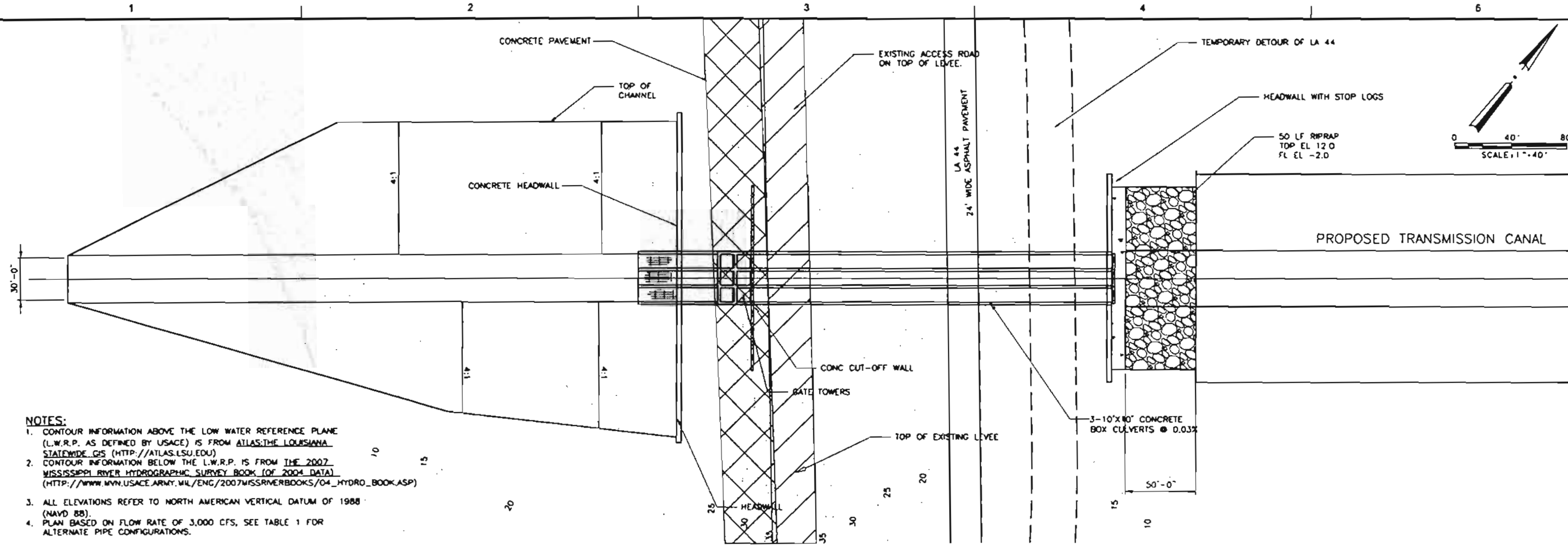
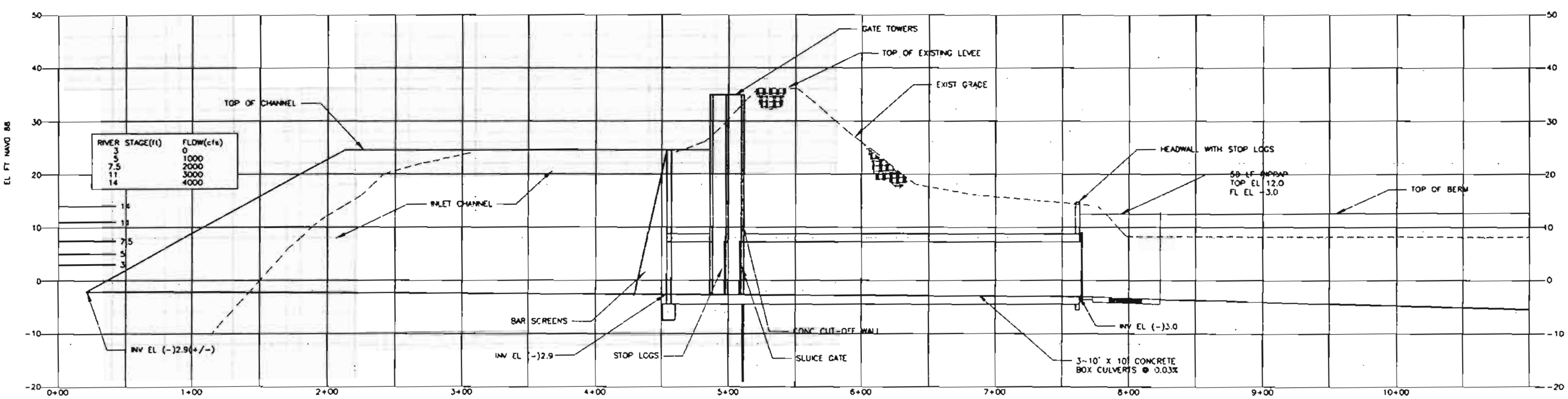
APPENDIX



NOTES:
1. CONTOUR INFORMATION ABOVE THE LOW WATER REFERENCE PLANE (L.W.R.P. AS DEFINED BY USACE) IS FROM ATLAS:THE LOUISIANA STATEWIDE GIS (HTTP://ATLAS.LSU.EDU)
2. CONTOUR INFORMATION BELOW THE L.W.R.P. IS FROM THE 2007 MISSISSIPPI RIVER HYDROGRAPHIC SURVEY BOOK (OF 2004 DATA) (HTTP://WWW.MVN.USACE.ARMY.MIL/ENG/2007MISSRIVERBOOKS/04_HYDRO_BOOK.ASP)
3. ALL ELEVATIONS REFER TO NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88).
4. PLAN BASED ON FLOW RATE OF 3,000 CFS. SEE TABLE 1 FOR ALTERNATE PIPE CONFIGURATIONS.



US Army Corps of Engineers
New Orleans District

MARK	DESCRIPTION	DATE	APPR	MARK	DESCRIPTION	DATE	APPR

U.S. ARMY CORPS OF ENGINEERS
NEW ORLEANS DISTRICT
NEW ORLEANS, LOUISIANA

CDM
1515 POYDRAS ST. SUITE 1350
NEW ORLEANS, LOUISIANA 70112

DLS CHKD BY: WILLIAMS | DATE: 2009/12
DWN BY: BUCKLAND | CKD BY: WILLIAMS
SUBMITTED BY: CDM
PLOT SCALE | PLOT DATE: 6/1/2010 | FILE NUMBER:
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BLIND RIVER FRESHWATER DIVERSION
FEASIBILITY STUDY
ST. JAMES PARISH, LOUISIANA

ROMEVILLE CULVERT
PLAN AND PROFILE

SHEET IDENTIFICATION
C-002

Enclosure 5