Appendix A-1

Biological Assessment
U.S. Fish and Wildlife Service

U.S. ARMY CORPS
OF ENGINEERS
NEW ORLEANS DISTRICT

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BIOLOGICAL ASSESSMENT for LCA - Medium Diversion at White Ditch

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[Cover Photo: Existing siphon at White Ditch]

Introduction

This Biological Assessment (BA) is submitted to the U.S. Fish and Wildlife Service (USFWS) by the U.S. Army Corps of Engineers, New Orleans District (CEMVN) in order to initiate formal consultation with USFWS regarding potential impacts to threatened and endangered species from construction and operation of the LCA Medium Diversion at White Ditch (MDWD) project. The following BA is promulgated in accordance with Section 7 (Interagency Consultation) of the Endangered Species Act of 1973, as amended (PL 93-205; 16 U.S.C. 1531 et. seq.). A separate BA has been prepared and will be submitted to the National Marine Fisheries Service for species under their purview, including Gulf sturgeon (*Acipenser oxyrhynchus desotoi*), green sea turtle (*Chelonia mydas*), hawksbill sea turtle (*Eretmochelys imbricate*), Kemp's ridley sea turtle (*Lepidochelys kempii*), leatherback sea turtle (*Dermochylys coriacea*), and the loggerhead sea turtle (*Caretta caretta*).

The purpose of this biological assessment is to evaluate the possible effects of the proposed construction and operation of the MDWD project on threatened, endangered and proposed threatened and endangered species and their habitats. Threatened, endangered and proposed threatened and endangered species are managed under the authority of the Federal Endangered Species Act (ESA) (PL 93-205, as amended). Under provisions of the ESA, Federal agencies shall use their authorities to carry out programs for the conservation of listed species, and shall insure any action authorized, funded, or implemented by the agency is not likely to: (1) adversely affect listed species or designated critical habitat; (2) jeopardize the continued existence of proposed species; or (3) adversely modify proposed critical habitat (16 USC 1536).

The species of concern that are known to inhabit the area are:

Threatened, Endangered, and Proposed Threatened or Endangered Species

Pallid Sturgeon (*Scaphirynchus albus*), was listed as endangered throughout its range on October 9, 1990 (55 FR 36641-36647)

West Indian Manatee (*Trichechus manatus*), was listed as endangered on June 2, 1970 (35 FR 8491, Appendix A)

Piping Plover (*Charadrius melodus*), was listed as threatened and endangered on December 11, 1985 (50 FR, 50720-50734)

Sensitive Species and Species of Concern

Bald Eagle (*Haliaeetus leucocephalus*), was de-listed on August 9, 2007 (72 FR 37345 37372)

Brown Pelican (*Pelecanus occidentalis*), was de-listed on November 17, 2009 (74 FR 59443 59472)

Colonial Nesting Birds

Critical Habitat

No critical habitat is currently designated for any of the threatened, endangered, or sensitive species within the project area.

Previous Consultation

Informal coordination with the USFWS Lafayette, LA office, for the effects to pallid sturgeon from entrainment through diversion structures, has been ongoing since the 2008 operation of the Bonnet Carre Spillway. There has been no coordination conducted for the proposed action described in this document.

Purpose

This LCA Medium Diversion at White Ditch (MDWD) project is to help restore areas where an altered supply and distribution of freshwater, lack of deltaic forming sediments, marsh subsistence and human development in the White Ditch area have resulted in degraded and unbalanced distribution of freshwater, brackish, and saltwater marsh habitats. Further, the degradation of the existing marshes has made them more vulnerable to the range of Gulf storm events; extreme and seasonal, resulting in accelerated degradation, altered hydrology and changed salinity regimes.

Installation of the White Ditch diversion siphon was completed in 1963 with the objective of enhancing muskrat and oyster habitat. In the absence of an outfall management plan, the surrounding marsh received limited benefits from the diverted river water. Two 50-inch steel pipes divert water from the Mississippi River through the White Ditch, into the Belair Canal and then into the River aux Chenes, where it continues south and out of the project area. Usage of the siphons was abandoned for many years and they degraded into a non-usable condition. The siphons were recently refurbished and water was diverted into White Ditch as part of research efforts.

Wetlands in the project area are deteriorating for several reasons: 1) subsidence, 2) lack of sediment and nutrient deposition, 3) erosion via tidal exchange, 4) channelization, 5) saltwater intrusion and 6) lack of freshwater. Recent hurricanes and tropical storms have also caused significant damage to the project area. These activities have resulted in the loss of several thousand acres of previously solid, vegetated marsh. Deterioration will continue unless preventative measures are taken.

In the absence of supplemental freshwater and sediment from the Mississippi River, subsidence, sea-level rise, wave erosion, and saltwater intrusion will continue to be problems. Protection and enhancement of this area are dependent on providing a hydrologic and sediment regime that minimizes the physiological stress to wetland vegetation from saltwater intrusion and tidal energy and is conducive to the retention of locally provided freshwater and sediments

The historic geology of the project area indicates that the current course of the Mississippi River has remained the same for the last 700 years and has directly influenced the development of the entire area. The project area is located on the east side of the Mississippi River and was formed between two natural levee ridge systems, River aux Chenes on the east and the Mississippi River on the west. There are also two unnamed bayou ridges found within the project area. These ridges formed along the old natural bayous which were distributary channels for the Mississippi River. These natural bayous once carried sediments and nutrients into the project area during high river stages when the natural ridges were seasonally overtopped.

In the historical setting, floodwater from the river would recede and sediments and nutrients would be deposited in the inter-distributary basins located between ridges. During normal or low river stages the ridges along the distributary channels served like levees and buffered the basin areas from the daily tidal influence. This buffering effect created a low energy freshwater environment in the inter-distributary basins, forming deep organic soils. Drainage to the area was provided by a high water event breaching the River aux Chenes ridge in the southern part of the project area. This event caused the development of the Bayou Garelle tributary channel.

The present day hydrology of the project area has been altered and no longer functions in a historically natural pattern. Historically, water moved very slowly through the system. Freshwater slowly exited the system through meandering pathways in the marsh and saltwater was slow to intrude. Presently, changes in the marsh allow water to rapidly pass through the system and saltwater is able to quickly intrude. The hydrologic balance within the marsh has been disturbed due to the following man-made changes:

1. The Mississippi River can no longer overflow its banks into the project area due to the Mississippi River protection levee. This has eliminated the introduction of freshwater from the river and disrupted natural sediment deposition patterns.
2. Channels have been dredged through natural ridges which has increased drainage and tidal exchange and exposed the soil to erosive forces.

This project was identified as a Near-term Critical Restoration Feature Recommended for Study and Future Congressional Authorization in the LCA Main Report dated January 21, 2005. In November 2007, the Water Resources Development Act of 2007 passed, authorizing this and other projects from the LCA Main Report. The MDWD feasibility study is anticipated to result in a Chief's Report containing a recommended plan to construct a Mississippi River diversion in the vicinity of White Ditch for the purposes of introducing freshwater, sediments, and nutrients into the study area.

Location of the Proposed Action

The MDWD project study area is located in LCA Subprovince 1 in the Breton Sound hydrologic basin in Plaquemines Parish, Louisiana (see Figure 1). The boundary of the project encompasses over 98,000 acres of intermediate to brackish intertidal wetland habitats that has been heavily influenced by both man-made and natural processes. Channel construction, subsidence, erosion, saltwater intrusion, and storm-related damages have all significantly altered the natural environment, causing extensive losses of wetland habitats. The study area boundary follows distinct landscape features beginning in the north with the confluence of the non-Federal back levee and the forty-arpent canal, extending along the non-Federal back levee, the Mississippi River levee, the Federal back levee and along the left descending natural bank of the Mississippi River to the west; past American Bay, California Bay, and through Breton Sound, near Bay Gardene to the south; into and along River aux Chenes to the east, and back to the point of beginning. The area has been significantly impacted by recent tropical storms and hurricanes and is currently isolated from the effects of the Caernarvon freshwater diversion, located at the northern end of the Breton Sound basin.

There are two discreet project locations that will be considered for the purposes of the feasibility study: The area along the Mississippi River where a freshwater diversion structure might be located; and the project area that could be influenced and benefited by the diverted freshwater. The area of interest where a diversion structure could be located occurs on the left descending bank of the Mississippi River, between White Ditch to the north (river mile 64.5) and the community of Phoenix to the south (river mile 59.8). This 4.7 mile stretch is unique in that there is no hurricane protection levee (back levee) on the marsh side that protects existing homes and infrastructure from elevated water levels (tidal or storm surge). The Mississippi River levee is the only flood protection structure that keeps river water from entering the project study area. This situation minimizes the amount of infrastructure that could be affected by construction of a diversion structure and allows for a broader array of measures to be considered in addressing problems in the project area.

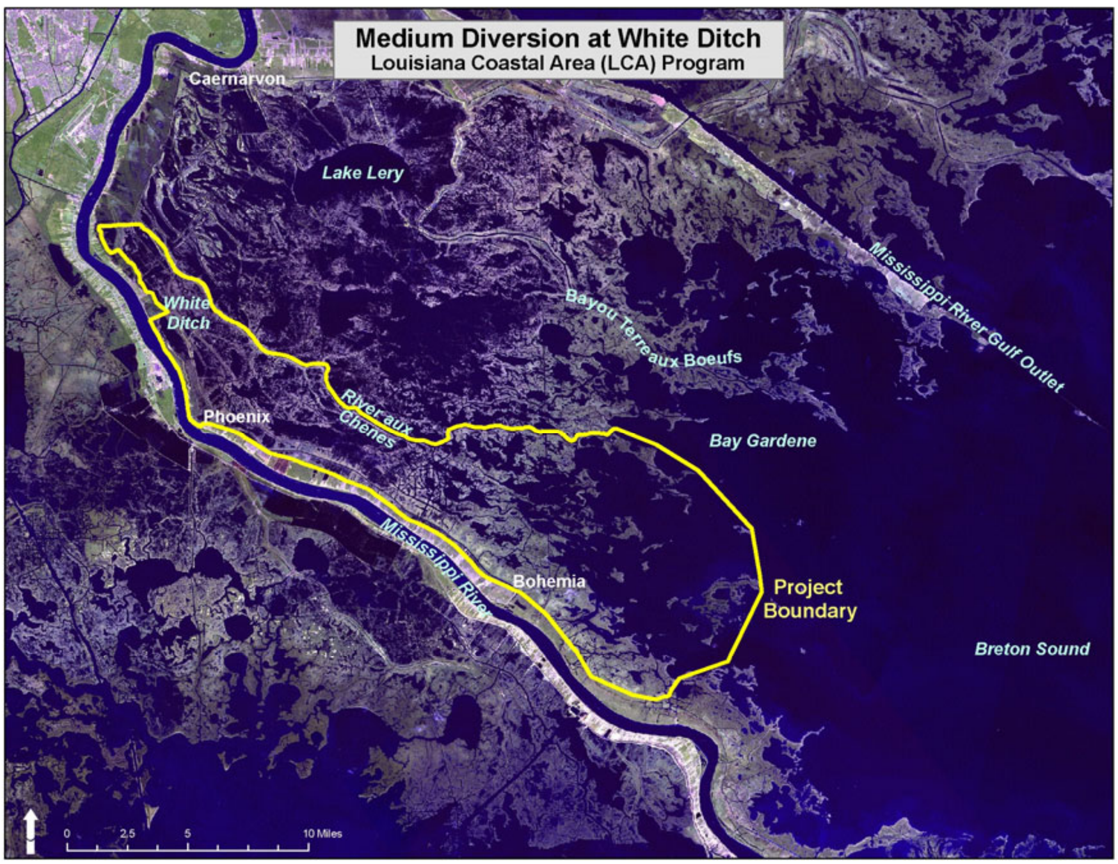

Figure 1: Study Area Map

Proposed Action

The tentatively selected plan proposes the construction of a medium sized diversion structure capable of diverting up to 35,000 cfs consisting of 10 15-ft. x 15-ft. box culverts with hydraulic operated sluice gates, and constructing an outfall channel to carry fresh water and sediment to the desired locations in the marsh. Additionally, there will be 32 acres of ridge and terrace creation and 385 acres of marsh creation utilizing dredged material from an adjacent 223 acres of canal being reconfigured to convey freshwater, nutrient and sediments.

The current operating plan for the tentatively selected plan at the White Ditch Diversion is limited to a diversion pulse of 35,000 cfs in March-April of each year, during the normal high flow period of the Mississippi River, and a diversion of 1,000 cfs the rest of the year. This flow rate may not be experienced over the full 60-day period. The proposed 35,000 cfs diversion will be the largest man-made diverted flow for wetland building on the Lower Mississippi River, but the one to two month duration will be a modifying factor. The diversion should approximate five percent or less of the main channel flow for most years.

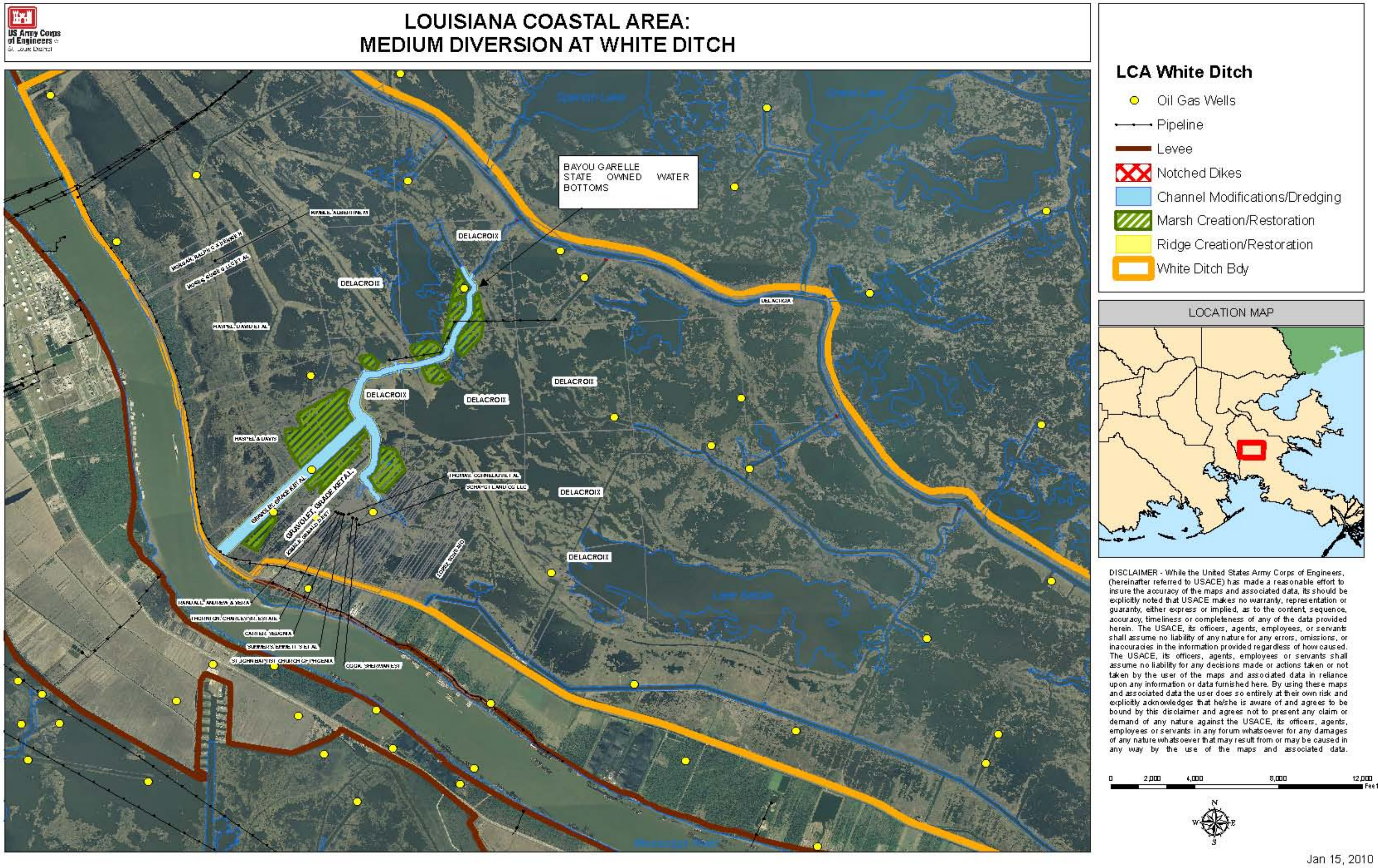

Figure 2: Proposed Medium Diversion at White Ditch

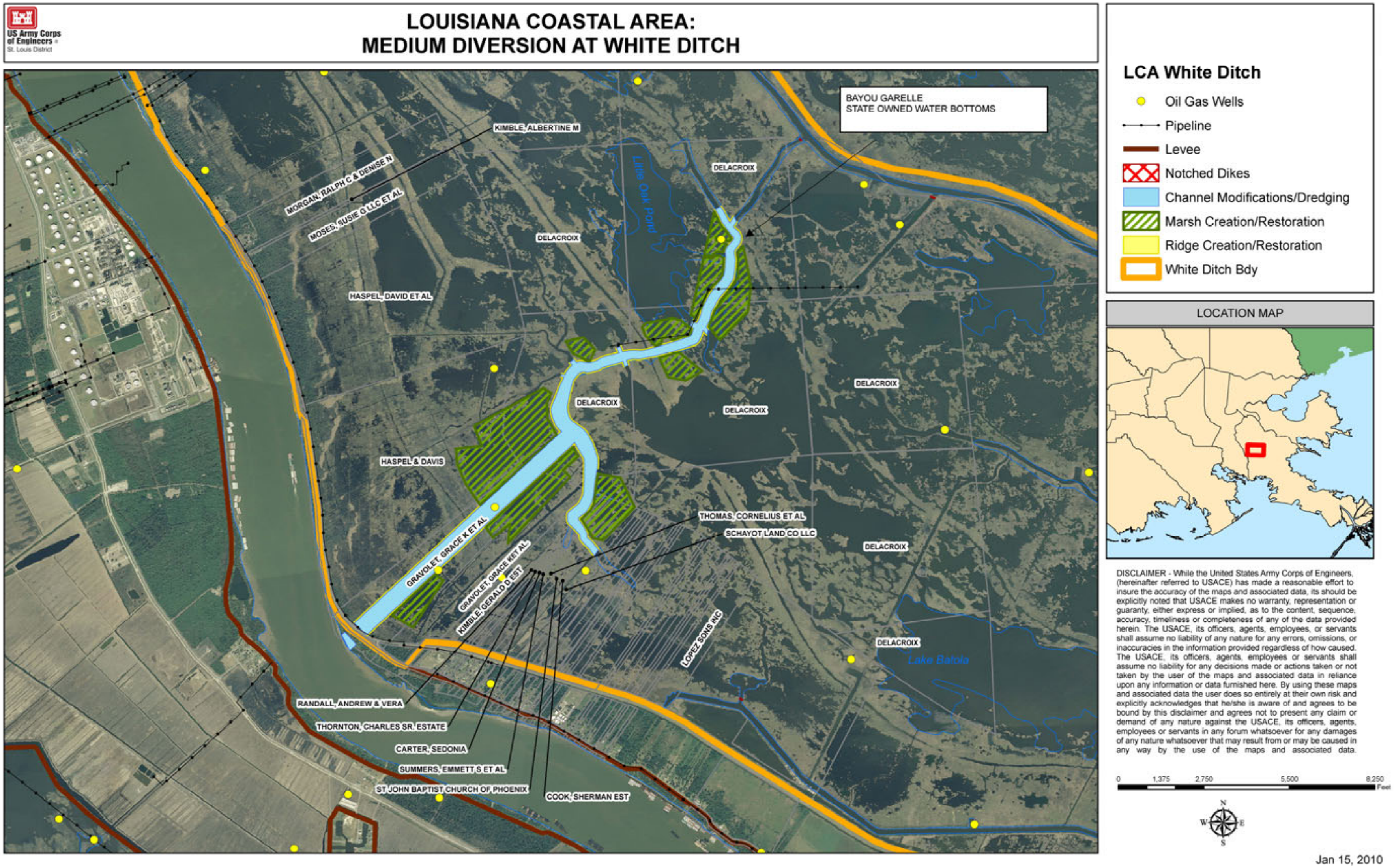

Figure 3: Map of Proposed Medium Diversion at White Ditch

Species Descriptions

Pallid Sturgeon (*Scaphirynchus albus*)

Status

The pallid sturgeon was listed as endangered throughout its range on October 9, 1990 (55 FR 36641-36647). The reasons for listing were habitat modification, apparent lack of natural reproduction, commercial harvest, and hybridization in parts of its range. To date no critical habitat has not been proposed or designated for this species.

Species and Habitat Description

The pallid sturgeon is a bottom oriented, large river obligate inhabiting the Missouri and Mississippi Rivers from Montana to Louisiana and the Atchafalaya River. The pallid sturgeon is adapted to the predevelopment habitat conditions that historically existed in these large rivers. 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. Floodplains, backwaters, chutes, sloughs, islands, sandbars and main channel waters formed the large-river ecosystem that provided 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 in the Mississippi River and main channel areas with islands or sand bars in the upper Missouri River (USFWS 2009).

Pallid sturgeon are Federally listed as endangered and have been described as one of the rarest fish in North America. The pallid sturgeon was listed due to 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 decline in reproduction, growth, and survival of the pallid sturgeon. The curtailment of range and habitat destruction/modification were primarily attributed to the construction and operation of dams on the upper Missouri River and modification of riverine habitat by channelization of the lower main stem Missouri River and Mississippi Rivers. Dams substantially fragmented pallid sturgeon range in the upper Missouri River. However, free-flowing riverine conditions currently exist throughout the lower 2,000 mi (3218 km) (60%) of the pallid sturgeon’s historical range (USFWS 2009). Until this past decade, they were considered a rare occurrence in the Lower Mississippi. New information from recent collection efforts indicates that the Mississippi River currently supports substantial numbers of wild fish. Since 1997, more than 200 pallid have been collected at more than 60 locations in the Mississippi River between the confluence of the Missouri River and New Orleans, LA (Bettoli, 2006). When listed, there were only 28 recognized records of pallid sturgeon from the Mississippi River, with no recognized records from the Atchafalaya River (USFWS 2009).

Pallid sturgeon feed on a range of animals from aquatic insects to fish depending upon life stage. Individuals of the species can be long lived with females reaching sexual maturity later than males. Spawning is thought to take place in side channels and backwaters and appears to occur between June and August. Larval fish produced from the spawning event drift downstream from the hatching site and begin to settle from the lower portion of the water column 11 to 17 days post hatch. 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 (USFWS 2007). Although pallid sturgeon captures in the middle and lower reaches of the Mississippi River continue to increase with fishing effort, habitat use, population levels and trends, and movement patterns within this portion of the species range remain unknown. Extensive sampling in the lower Mississippi River is currently being undertaken by U.S. Army Corps of Engineers Engineering Research and Development Center (ERDC) so that a better understanding of population size, population density, habitat preference, extent of range in lower Mississippi River, and impacts from entrainment on the population can be quantified.

Forbes and Richardson (1905), Schmulbach et al. (1975), Kallemeyn (1983), and Gilbraith et al. (1988) describe pallid sturgeon as being a fish well-adapted to life on the bottom in swift water of large, turbid, free-flowing rivers. Mayden and Kuhajda (1997) describe the natural habitats to which pallid sturgeon are adapted as: braided channels, irregular flow patterns, flooding of terrestrial habitats, extensive microhabitat diversity and turbid waters. 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 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 hand 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 Rovinson 1974). The still waters in this transition zone allow organic matter accumulations; important to macroinvertebrate production. Both shovelnose and pallid sturgeon have a high incidence of aquatic invertebrates in their diet (Carlson et al. 1985; Gardner and Stewart 1987). Flood flows connected those important habitats and allowed fish from the main channel to utilize those habitat areas and to exploit available food sources (USFWS 2009).

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 (USFWS 2007). On April 4, 2008, one week prior to the 2008 opening of the Bonnet Carre Spillway, personnel of the LDWF captured at least one pallid sturgeon in willow trees along the flooded bank of the river adjacent the Spillway structure. Although no diagnostic measurements were taken of the sturgeon, experts who have reviewed the photographic evidence have all concluded that the fish was a pallid sturgeon. This capture represents a very rare capture of a pallid sturgeon from the flooded riverbank of the river. Prior to this capture, pallid sturgeon were generally believed to inhabit only the main river channel and side slopes, not overbank areas during high-water events. It is not known if pallid sturgeon might also be found in grassy or revetted areas. Dr. Jack Killgore, who is in charge of the ERDC's sampling efforts, believes that pallid sturgeon could be found over nearly any flooded habitat, if enough sampling effort was expended, but they are more likely to be found in open water than in flooded willows. Currently as part of the sampling effort being performed by ERDC habitat data is being collected to better understand what habitat features are attracting the pallid sturgeon to swim up in the water column and to the flooded river banks which makes them more prone to entrainment by diversion structures.

Genetic and morphological data have been used to differentiate pallid sturgeon into three groupings, an upper Missouri River group and two less differentiated groups in the lower Missouri/middle Mississippi and Atchafalaya River (USFWS 2007). This data suggest that the genetic structuring within the pallid sturgeon's range represents two distinct groups at the extremes of the species range with a middle intermediate group representing the lower Missouri and middle Mississippi Rivers. This pattern is suggestive of a pattern of isolation by distance, with gene flow more likely to occur between adjacent groups than among geographically distant groups, and thus, genetic differences increase with geographical distance.

Management and Protection

Aquatic habitats in the Mississippi River have been modified though the construction of flood control levees and channel modification through time, and some changes resulting from those modifications have likely been detrimental to pallid sturgeon (USFWS 2007). Although the river flows unobstructed for about 2,000 river miles (RM) from Gavins Point Dam in the middle Missouri River to the Gulf of Mexico, tributary impoundments, bendway cutoffs, and dike and levee construction have each changed localized patterns of channel erosion and deposition in the Mississippi River; collectively they resulted in a degradation trend throughout the system. Effects of these changes on pallid sturgeon are unknown, because there are no historical data for comparison. In 1981, the USACE established the Lower Mississippi River Environmental Program, with a goal of protecting fisheries and other natural resources in the lower Mississippi River (USFWS 2007). Input from the Lower Mississippi River Environmental Program resulted in experimentations with dike placement and notches as measures to protect secondary channels and maintain shallow water and fisheries habitats.

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. While recent publications have contributed to filling some of these data gaps (e.g., Killgore et al., 2007) incomplete knowledge of those areas remains. Therefore, the sturgeons' response and the effect to encountering the diversion flows (e.g., avoidance, actively sought) is unknown, which can affect the number of sturgeon believed to be "taken" by a structure's operation. It is not know if the number of sturgeon that risk entrainment within a diversion structure are; only those located near the structure during its opening (no increase in sturgeon entrained because of active avoidance); are sturgeon that 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., spillway); or are entrained during down-river migration passively (i.e., no avoidance) or actively (i.e., failed to resist entrainment) or a combination of any of the above. There are no known topographic or hydrographic features that would appear to attract the sturgeon to the vicinity of the MDWD (USFWS 2009).

Water diversions are used for flood control, water supply, and habitat restoration in the lower Mississippi River (LMR) but their impacts on imperiled sturgeon populations are unknown. Comprehensive risk assessments for entrainment of sturgeon by water diversions require substantial inputs including field data on local sturgeon populations, life history information, output from population modeling simulations, and results of experimental studies. These risk assessments, however, can provide probability of entrainment for specific environmental scenarios (e.g., time of year, river stage, and flow fields generated by a structure). After the entrainment of 14 pallid sturgeon by a diversion structure was documented during the 2008 operation of the Bonnet Carre Spillway the USFWS tasked CEMVN with researching what effect diversion structures might have on the pallid sturgeon. CEMVN tasked ERDC with analyzing the effects and a scope of work (SOW) was prepared. The SOW provided details on materials and methods of sampling, duration, etc. and was provided to the USFWS Lafayette, LA office for review. The USFWS provided its comments on the SOW. Since this time ERDC has contracted USFWS Fisheries Biologist's from the Baton Rouge, LA office as well as Dr. Dave Shultz from Nicholls State University to assist in sampling river sites within the vicinity of existing and proposed diversion structures.

ERDC has documented numerous shovelnose and pallid sturgeon within two of the three reaches of the Mississippi River with proposed or existing diversions, and trotline data provide estimates of relative abundance among adjacent reaches (Table 1). No sturgeon have been collected from RM 0-70, the reach including White's Ditch and the proposed Myrtle Grove diversion. Only four adult sturgeon have been collected from RM 70-100, the reach containing Violet siphon and Caernarvon. Catch-per-unit-effort (CPUE) values for shovelnose sturgeon (0.14/trotline) and pallid sturgeon (0.05/trotline) are low, compared to those previously documented (1.88-5.41/trotline and 0.12-0.31/trotline, respectively) suggesting that densities are substantially lower than elsewhere in the free-flowing Mississippi River (Killgore et al., 2007). Over 150 sturgeon have been collected from RM 100-200, the reach including Davis Pond and Bonnet Carre, and the proposed Convent/Blind River and Hope Canal projects. CPUE is relatively low in this reach for shovelnose sturgeon (0.79/trotline) but high for pallid sturgeon (0.32/trotline). More than 200 sturgeon have been collected from RM 200-300 where no diversions are under consideration. CPUE is relatively high in this reach for shovelnose sturgeon (6.0/trotline) and pallid sturgeon (0.25/trotline). Trawling data are less robust than trotline data but support a longitudinal trend of greater sturgeon abundance upriver.

The data indicates entrainment risk by diversions to pallid sturgeon. Although catch rates are comparatively low in the affected reaches, ratios of pallid sturgeon to shovelnose sturgeon are high: 1:3 in RM 70-100, 1: 2.4 in RM 100-200. These ratios are substantially greater than the 1:6 ratio documented previously for RM 154-502 and 1:16 to 1:36 ratios observed elsewhere (Killgore et al., 2007). Young-of-year sturgeon, with weaker swimming abilities than adults (Adams et al., 1997; Adams et al., 1999) also occur and will be at greater risk of entrainment. To date, entrainment of pallid sturgeon has been documented for the Davis Pond diversion and Bonnet Carre spillway.

Table 1: Summary of effort and number of sturgeon collected from the Mississippi River during the period 2001-2009.

River Mile	Gear	Times Deployed	Number of Shovelnose sturgeon	Number of Pallid sturgeon	Number of Sturgeon yoy
0-70	Trotline	21	0	0	0
	Trawl	21	0	0	0
70-100	Trotline	21	3	1	0
	Trawl	10	0	0	2
100-200	Trotline	150	118	49	
	Trawl	46	1	0	5
200-300	Trotline	31	186	8	0
	Trawl	16	11	1	5

Commercial take of any species of sturgeon was prohibited by Mississippi and Louisiana during the early 1990s to avoid incidental take of pallid sturgeon. Although some poaching of the species probably still occurs this value is not quantifiable. Other factors which threaten the species include: predation, disease, contaminants, tug boat propeller entrainment, and hybridization.

West Indian Manatee (*Trichechus manatus*)

Status

The West Indian manatee was listed as endangered throughout its range for both the Florida and Antillean subspecies on June 2, 1970 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 in length and weigh up to 2,200 pounds. 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 2001). 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 5 hours a day feeding, and may consume 4 to 9 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 3 to 6 years of age. Mature females may give birth every 2 to 5 years (USFWS 2001).

Manatees inhabit both salt and freshwater of sufficient depth (5 feet to usually less than 20 feet) throughout their range. Shallow grassbeds with ready access to deep channels are preferred feeding areas in coastal and riverine habitats (USFWS 2001). They may also be encountered in canals, rivers, estuarine habitats, saltwater bays, and have been observed as much as 3.7 miles 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.

During 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. Power plant and paper mill outfalls created most of the artificial warm water refuges utilized by manatees. During summer months, they migrate as far north as coastal Virginia on the east coast and the Louisiana coast in the Gulf of Mexico.

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 (O'Shea 1988). In the warmer months, manatees usually occur alone or in pairs, although interacting groups of 5 to 10 animals are not unusual (USFWS 2001). A few individuals have been known to stray as far north as the northern Georgia coast and as far west as the coastal waters of Louisiana.

In the early 1980s, scientists tried to develop procedures for estimating the overall manatee population in the southeastern United States (USFWS 2001). 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. Manatees were reported in Lake Pontchartrain prior to the landfall of Hurricane Katrina, however, there were no reports of manatee mortality following the hurricane.

Management and Protection

The most significant problem faced by manatees in Florida is death or injury from boat strikes (USFWS 2001). 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 2001). 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 2001).

The West Indian manatee is also 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 2001).

Piping Plover (*Charadrius melodus*)

Status

The USFWS determined the piping plover to be endangered and threatened on December 11, 1985. Endangered status was determined for the plover in the watershed of the Great Lakes (Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, Wisconsin, and Ontario). It was determined to be threatened in the remainder of its range: northern Great Plains (Iowa, northwestern Minnesota, Montana, Nebraska, North Dakota, South Dakota, Alberta, Manitoba, and Saskatchewan); Atlantic coast (Quebec, Newfoundland, Maritime Provinces, and states from Maine to Florida); Gulf coast (Florida to Mexico); Bahamas; and West Indies.

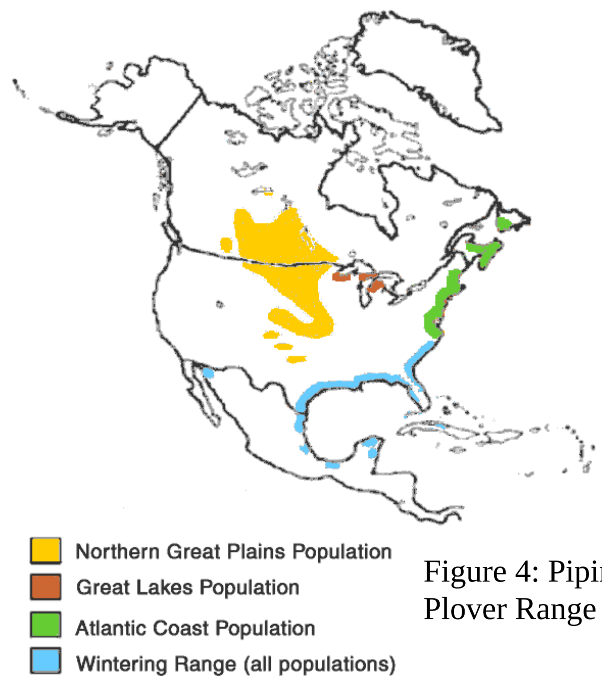

Figure 4: Piping Plover Range

Species and Habitat Description

The piping plover is a shorebird that inhabits open beaches, alkali flats, and sandflats of North America. It breeds primarily along the Atlantic coast from North Carolina to southern Canada, along rivers and wetlands of the northern Great Plains from Nebraska to the southern prairie provinces, and along portions of the western Great Lakes. In winter, most individuals are found on coastal beaches and sand flats from the Carolinas to Yucatan; some scatter through the Bahamas and West Indies. (Haig, 1992)

This plover is divided into two subspecies based on geographic distribution and presence or absence of complete neck bands, although there is little support for this designation (Haig and Oring 1988a). Numerous breeding studies have been conducted across the species range, yet habitat requirements and limiting factors remain poorly known. Conservation efforts are well organized in breeding areas across North America, whereas little has been attempted in winter areas.

Ideal wintering habitat for the piping plover on the Gulf of Mexico coast would contain large sand flats or sand-mud flats adjacent to a tidal pass or tidal inlet (Haig 1985, Nicholls 1989). A thin layer of mud covering the sand seems to attract plovers, due to possible food or refuge association (Nicholls 1989). Nicholls observed that barrier beaches with over wash areas or sections of old marshes also attract plovers. A gulf-facing beach having a very low gradient, thus an increased intertidal zone, offers an almost equally attractive area (Haig 1985). Also piping plovers will inhabit spoil islands on the Gulf Intracoastal Waterway on both Atlantic and Gulf Coasts. Birds are frequently associated with bays, lagoons and inlets. Winter 2001 census observations were in the following habitat type: mudflats (36.3%), sandy beaches (33.2%), sand/salt flats (23.1%) algal mats (2.8%), oyster reefs (1.0%) and gravel shores (0.1%; Haig 2004).

Foraging habitat in winter is fairly consistent among numerous Gulf and Atlantic coast sites. On Dauphin Island, AL: protected mudflats or sandflats exposed at low tide; at Texas sites: primarily bayshore sand and algal flats. Comparison among 36 Atlantic winter sites (222 birds observed once each) and 75 Gulf sites (1,508 birds observed once each) indicates foraging activity most often associated with mudflats (25.6% of observations), sandflats (25.1%), and sandy mudflats (31.8%; Haige, 2004).

The historical breeding range in North America of the piping plover included the Atlantic coastal beaches from Newfoundland to South Carolina; beaches of the Great Lakes; and the northern Great Plains region from Alberta to Ontario and south to Nebraska (USFWS, 1988). These populations were reported to winter along the Gulf of Mexico, the Atlantic coast from North Carolina to Florida, eastern Mexico, and in the Caribbean Islands (Haig and Oring, 1985). Approximately 35 percent of the total breeding piping plover population winters along the gulf coast from Florida to Texas and represents 56 percent of the Great Lakes/Great Plains population (Natureserve 2002, 2003).

All populations could potentially occur within the proposed action areas since it falls within the wintering range of the species. They arrive from their northern breeding grounds as early as late July and may be present for 8 to 10 months of the year. Inland breeders appear to migrate nonstop to the Gulf of Mexico or Atlantic Coast. Great Lakes and Northern Plains birds are rare at seemingly appropriate inland stopover places: Great Salt Plains National Wildlife Refuge, OK, and Cheyenne Bottoms National Wildlife Refuge, KS (Haig, 1986). Existing stopover records suggest that migration routes are predominantly south/southeast in the fall. In fall, birds depart Massachusetts breeding sites by late August (Haig, 2004). Some Manitoba and North Dakota, but others with nests hatching late July or early August stay into September. Generally, females go first, then unpaired males, males with fledglings, followed by unaccompanied juveniles. Peak return to Texas beaches is in August and September, although small numbers may arrive as late as November. Adults may arrive before juveniles as early captures in Texas were of adult birds (sex unknown) and juveniles were not recorded until early November; however, since sample size was small further research is needed.

Management and Protection

Hunting in the early 1900s resulted in a drastic reduction of the piping plover population. Ongoing destruction of historical nesting sites further reduced plover populations (USFWS 1988). The primary causes for decline of this species are listed as habitat loss and degradation and human disturbance. Loss of breeding habitat has resulted from recreation and commercial development of sandy beaches on the Great Lakes, Atlantic Coast, and Gulf of Mexico. Where breeding does occur on coastal beaches, inland lakes, and river sites, reproductive success has been reduced by disturbance from humans and pets. Additional habitat has been lost due to construction and operation of reservoirs and river channelization.

Dune stabilization projects that result in steep beach slopes, narrower beach widths, or increased vegetation to the water's edge, reduce piping plover habitat (Haig 1985). In at least one instance, stabilization of the backside of the dune on Padre Island, Texas, resulted in the destruction of essential sand flat habitat (USFWS ESIS). Additionally, increased urbanization has led to an increase in predation on the piping plover population (USFWS 1988). Recreational activities in localized areas along the gulf coast have been correlated with a decrease in piping plover use of those areas (Nicholls 1989).

Habitat loss is a problem on both breeding and wintering grounds. It occurs when nesting beaches or basins become unsuitable or unavailable to piping plovers through natural causes such as drought, vegetation encroachment, tides and floods, as well as through activities such as beach visitation, housing developments, cattle ranching and water management. Natural factors will undoubtedly continue to be an unpredictable challenge for piping plover recovery in the future, and habitat loss due to human activity will increase with demands for more resources, recreation and living space, as the human population continues to grow (National Recovery Plan).

Bald Eagle (*Haliaeetus leucocephalus*)

Status

The successful recovery of bald eagle populations within the continental United States resulted in the delisting of the species from the Endangered Species List by the FWS on August 9, 2007. The bald eagle may nest in some of the remaining large cypress trees within the project area. Though delisted, bald eagles and other raptors are still protected by the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. Following the National Bald Eagle Management (NBEM) Guidelines to minimize potential adverse impacts to bald eagles, a "no-work" distance would be established within 660 feet of any bald eagle nests occurring in the project area, during the breeding season, from October 1 thru May 15. In addition, the Division of Migratory Birds for the Southeast Region of the FWS would be contacted prior to start of project activities to update the status of known bald eagle nests and to ascertain if any new nest are discovered within or adjacent to the proposed disposal site. It is expected that the tentatively proposed plan is not likely to adversely affect the bald eagle.

Brown Pelican (*Pelecanus occidentalis*)

Status

The successful recovery of the brown pelican population within the continental United States resulted in the delisting of the species from the Endangered Species List bye the FWS on November 17, 2009. Though delisted, brown pelicans are still protected by the Migratory Bird Treaty Act. The brown pelican is a year-round resident of Louisiana that typically forages on fishes throughout the study area. This colonial nester has established a colony on Raccoon Point on Isles Dernieres, Queen Bess Island, Plover Island (Baptiste Collette), Wine Island, and islands in the Chandeleur chain. In winter, spring, and summer, nests are built in mangrove trees or other shrubby vegetation, although occasional ground nesting may occur. Small coastal islands and sand bars are typically used as loafing areas and nocturnal roosting areas. It is expected that the tentatively proposed plan is not likely to adversely affect the brown pelican.

Colonial Nesting Birds

Status

Colonial nesting birds may nest in the area. Colonial nesting marine birds and wading birds (waterbirds) share the characteristic of typically nesting in colonies. They represent several orders of waterbirds, (i.e. cormorants, herons, egrets, ibises, gulls, terns, and skimmers**)** and are important and conspicuous components of coastal ecosystems. With there tendency to nest in colonies disturbance and habitat modifications can affect large numbers of them at one time.

Colonial nesting wading birds (including, but not limited to herons, egrets, and ibis) and seabirds/waterbirds (including, but not limited to terns, gulls, black skimmers, and brown pelicans) should be avoided to reduce the risk of injuring birds. The nesting activity period generally extends from February 15 through September 15. No colonial nesting bird colonies are known to exist in areas that would be directly affected by the proposed action. The lack of suitable colonial nesting habitat within the directly affected area strongly suggests that no nesting colonies would be affected. The Corps has standard procedures in place to investigate construction sites for the presence of colonial nesting birds prior to project construction. With these procedures in place, and the low probability of encountering colonial bird nesting sites, the proposed action is not likely to adversely affect these species.

Effects of the Proposed Action

Pallid Sturgeon (*Scaphirynchus albus*)

Unpublished data suggests that a pallid sturgeon may have been captured in the past in the Delta National Wildlife Refuge near the Head of Passes of the Mississippi River (Walther, personal communication.). However, due to the similarities of pallid sturgeon and shovelnose sturgeon, this record could be considered as questionable. Other than this account no pallid sturgeon have been captured and identified within the reach of river that abuts the proposed MDWD. ERDC’s current sampling effort has not yielded any pallid or shovelnose captures south of RM 70 to date. Since the MDWD is located at RM 64.5, the risk of entrainment by this diversion structure is low. Though it may be possible for pallid sturgeon to inhabit the river as far south as the proposed MDWD, the population there is likely small if not non-existent. It is still plausible that a sturgeon feeding or otherwise occurring in the vicinity of the structure while it is operating may unwittingly be swept through the structure without even trying to offer any resistance, not realizing that once they go through the structure they cannot return on their own. The species evolved in an environment where there were no waterfalls or other natural obstructions that would have prevented upstream movement, no matter how far individual fish were swept downstream. So it may be possible that pallid (and shovelnose) sturgeon have no positive or negative rheotaxis in relation to anthropogenic structures such as the MDWD. Research at ERDC has been conducted on burst and long-term swimming speeds of pallid and shovelnose sturgeon. But, it is not known if the sturgeon's swimming ability is really a factor in the numbers that would be entrained during a diversion. Only the continuation of extensive field studies will be able to shed light on this subject. Given the results of our current sampling effort, CEMVN concludes that the risk to pallid sturgeon entrainment is low and that therefore the proposed MDWD may affect, but is not likely to adversely affect the species.

West Indian Manatee (*Trichechus manatus*)

Sightings of the West Indian manatee in Louisiana have primarily occurred in Lakes Pontchartrain and Maurepas, and associated coastal waters and streams (i.e., Amite, Blind, Tchefuncte, and Tickfaw Rivers) and a few rare sightings along the Gulf coast during the summer months (i.e., June through September); however, there is no known resident population in the State. To avoid potential impacts to manatees during restoration activities the following standard protective measures would be implemented;

- All contract personnel associated with the project should be informed of the potential presence of manatees and the need to avoid collisions with manatees, which are protected under the Marine Mammal Protection Act of 1972 and the Endangered Species Act of 1973.

- All construction personnel are responsible for observing water-related activities for the presence of manatee(s).

- Temporary signs should be posted prior to and during all construction/dredging activities to remind personnel to be observant for manatees during active construction/dredging operations or within vessel movement zones (i.e., work area), and at least one sign should be placed where it is visible to the vessel operator.

- Siltation barriers, if used, should be made of material in which manatees could not become entangled, and should be properly secured and monitored.

- If a manatee is sighted within 100 yards of the active work zone, special operating conditions should be implemented, including: no operation of moving equipment within 50 feet of a manatee; all vessels shall operate at no wake/idle speeds within 100 yards of the work area; and siltation barriers, if used, should be re-secured and monitored. Once the manatee has left the 100-yard buffer zone around the work area on its own accord, special operating conditions are no longer necessary, but careful observations would be resumed.

- Any manatee sighting should be immediately reported to the U.S. Fish and Wildlife Service (337/291-3100) and the Louisiana Department of Wildlife and Fisheries, Natural Heritage Program (225/765-2821).

Also, to prevent entrapment of manatee inside of dredged material receiving areas that have dikes or other retention features that enclose an area of open water, the area would be inspected for the presence of manatee: 1) before complete closure of the confining features, and 2) again before material is discharged in to the receiving area. Any manatee that is sighted should be allowed to leave the area before work resumes.

Adherence to the before mentioned protection measures will help ensure that any manatee that wanders into the project area would not be adversely affected. The disturbance to the manatee would only be temporary during project construction, and would result in temporary displacement. The manatees would likely move to another area for foraging or resting purposes, and there would be other available areas to which the animals may relocate. Since Louisiana has no resident population of West Indian manatee and the protection measures will be adhered to, it is expected that the proposed MDWD is not likely to adversely affect the species.

Piping Plover (*Charadrius melodus*)

During construction activities associated with the project any piping plover within the area will be temporarily displaced. The proposed action will create 235 acres of marsh in areas that are currently open water which will provide temporary foraging habitat for the Piping Plover until the mud flats become vegetated. The placement of this material will expose marine worms, mollusks, crustaceans and other small marine animals within the area allowing for easy foraging access to plovers in the area. As the marsh becomes vegetated there is potential for an increase in the number of mudflats within these areas that are presently open water. It is expected that the proposed MDWD is not likely to adversely affect the species.

Conclusion

Based on currently available historical and catch data, a review of current literature and studies, and with the employment of avoidance measures recommended through guidelines set up during coordination with USFWS, the CEMVN, believes that pallid sturgeon, West Indian manatees, and piping plover populations are not likely to be adversely affected from creation and operation of the MDWD in the project location detailed in this assessment.

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Appendix A-2

Biological Assessment
National Marine Fisheries Service

U.S. ARMY CORPS
OF ENGINEERS
NEW ORLEANS DISTRICT

September 2010

BIOLOGICAL ASSESSMENT for LCA - Medium Diversion at White Ditch

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[Cover Photo: Existing siphon at White Ditch]

Introduction

This Biological Assessment (BA) is submitted to the National Marine Fisheries Service (NMFS) by the U.S. Army Corps of Engineers, New Orleans District (CEMVN) in order to initiate formal consultation with NMFS regarding potential impacts to threatened and endangered species from construction and operation of the LCA Medium Diversion at White Ditch (MDWD) project. The following BA is promulgated in accordance with Section 7 (Interagency Consultation) of the Endangered Species Act of 1973, as amended (PL 93-205; 16 U.S.C. 1531 et. seq.). A separate BA has been prepared and will be submitted to the US Fish and Wildlife Service for species under their purview, including the Pallid Sturgeon (*Scaphirynchus albus*), West Indian Manatee (*Trichechus manatus*), and the Piping Plover (*Charadrius melodus*)

The purpose of this biological assessment is to evaluate the possible effects of the proposed construction and operation of the MDWD project on threatened, endangered and proposed threatened and endangered species and their critical habitats. Threatened, endangered and proposed threatened and endangered species are managed under the authority of the Federal Endangered Species Act (ESA) (PL 93-205, as amended). Under provisions of the ESA, Federal agencies shall use their authorities to carry out programs for the conservation of listed species, and shall insure any action authorized, funded, or implemented by the agency is not likely to: (1) adversely affect listed species or designated critical habitat; (2) jeopardize the continued existence of proposed species; or (3) adversely modify proposed critical habitat (16 USC 1536).

The species of concern that are known to inhabit the area are:

Threatened, Endangered, and Proposed Threatened or Endangered Species

Gulf Sturgeon (*Acipenser oxyrhynchus desotoi*), was listed as threatened on September 30, 1991 (56 FR 49653)

Green Sea Turtle (*Chelonia mydas*), was listed as threatened in U.S. waters, except for the Florida breeding population which was listed as endangered, on July 28, 1978 (43 FR 32800 32811)

Kemp’s Ridley Sea Turtle (*Lepidochelys kempii*), was listed as endangered throughout its range, on December 2, 1970 (35 FR, 18320)

Loggerhead Sea Turtle (*Caretta caretta*) was listed as threatened through out its range on July 28, 1978 (43 FR 32800 32811)

The likelihood of encountering hawksbill or leatherback sea turtles in the project area is so remote that those species are not included in this list of species. No further discussion of these species will occur.

Critical Habitat

No critical habitat is currently designated for any of the threatened, endangered, or sensitive species within the project area.

Previous Consultation

There has been no coordination conducted for the proposed action described in this document.

Purpose

This LCA Medium Diversion at White Ditch (MDWD) project is to help restore areas where an altered supply and distribution of freshwater, lack of deltaic forming sediments, marsh subsistence and human development in the White Ditch area have resulted in degraded and unbalanced distribution of freshwater, brackish, and saltwater marsh habitats. Further, the degradation of the existing marshes has made them more vulnerable to the range of Gulf storm events; extreme and seasonal, resulting in accelerated degradation, altered hydrology and changed salinity regimes.

Installation of the White Ditch diversion siphon was completed in 1963 with the objective of enhancing muskrat and oyster habitat. In the absence of an outfall management plan, the surrounding marsh received limited benefits from the diverted river water. Two 50-inch steel pipes divert water from the Mississippi River through the White Ditch, into the Belair Canal and then into the River aux Chenes, where it continues south and out of the project area. Usage of the siphons was abandoned for many years and they degraded into a non-usable condition. The siphons were recently refurbished and water was diverted into White Ditch as part of research efforts.

Wetlands in the project area are deteriorating for several reasons: 1) subsidence, 2) lack of sediment and nutrient deposition, 3) erosion via tidal exchange, 4) channelization, 5) saltwater intrusion and 6) lack of freshwater. Recent hurricanes and tropical storms have also caused significant damage to the project area. These activities have resulted in the loss of several thousand acres of previously solid, vegetated marsh. Deterioration will continue unless preventative measures are taken.

In the absence of supplemental freshwater and sediment from the Mississippi River, subsidence, sea-level rise, wave erosion, and saltwater intrusion will continue to be problems. Protection and enhancement of this area are dependent on providing a hydrologic and sediment regime that minimizes the physiological stress to wetland vegetation from saltwater intrusion and tidal energy and is conducive to the retention of locally provided freshwater and sediments

The historic geology of the project area indicates that the current course of the Mississippi River has remained the same for the last 700 years and has directly influenced the development of the entire area. The project area is located on the east side of the Mississippi

River and was formed between two natural levee ridge systems, River aux Chenes on the east and the Mississippi River on the west. There are also two unnamed bayou ridges found within the project area. These ridges formed along the old natural bayous which were distributary channels for the Mississippi River. These natural bayous once carried sediments and nutrients into the project area during high river stages when the natural ridges were seasonally overtopped.

In the historical setting, floodwater from the river would recede and sediments and nutrients would be deposited in the inter-distributary basins located between ridges. During normal or low river stages the ridges along the distributary channels served like levees and buffered the basin areas from the daily tidal influence. This buffering effect created a low energy freshwater environment in the inter-distributary basins, forming deep organic soils. Drainage to the area was provided by a high water event breaching the River aux Chenes ridge in the southern part of the project area. This event caused the development of the Bayou Garelle tributary channel.

The present day hydrology of the project area has been altered and no longer functions in a historically natural pattern. Historically, water moved very slowly through the system. Freshwater slowly exited the system through meandering pathways in the marsh and saltwater was slow to intrude. Presently, changes in the marsh allow water to rapidly pass through the system and saltwater is able to quickly intrude. The hydrologic balance within the marsh has been disturbed due to the following man-made changes:

1. The Mississippi River can no longer overflow its banks into the project area due to the Mississippi River protection levee. This has eliminated the introduction of freshwater from the river and disrupted natural sediment deposition patterns.
2. Channels have been dredged through natural ridges which has increased drainage and tidal exchange and exposed the soil to erosive forces.

This project was identified as a Near-term Critical Restoration Feature Recommended for Study and Future Congressional Authorization in the LCA Main Report dated January 21, 2005. In November 2007, the Water Resources Development Act of 2007 passed, authorizing this and other projects from the LCA Main Report. The MDWD feasibility study is anticipated to result in a Chief's Report containing a recommended plan to construct a Mississippi River diversion in the vicinity of White Ditch for the purposes of introducing freshwater, sediments, and nutrients into the study area.

Location of the Proposed Action

The MDWD project study area is located in LCA Subprovince 1 in the Breton Sound hydrologic basin in Plaquemines Parish, Louisiana (see figure 1). The boundary of the project encompasses over 98,000 acres of intermediate to brackish intertidal wetland habitats that has been heavily influenced by both man-made and natural processes. Channel construction, subsidence, erosion, saltwater intrusion, and storm-related damages have all significantly altered the natural environment, causing extensive losses of wetland habitats. The study area boundary follows distinct landscape features beginning in the north with the confluence of the non-Federal back levee and the forty-arpent canal, extending along the non-Federal back levee, the

Mississippi River levee, the Federal back levee and along the left descending natural bank of the Mississippi River to the west; past American Bay, California Bay, and through Breton Sound, near Bay Gardene to the south; into and along River aux Chenes to the east, and back to the point of beginning. The area has been significantly impacted by recent tropical storms and hurricanes and is currently isolated from the effects of the Caernarvon freshwater diversion, located at the northern end of the Breton Sound basin.

There are two discreet project locations that will be considered for the purposes of the feasibility study: The area along the Mississippi River where a freshwater diversion structure might be located; and the project area that could be influenced and benefited by the diverted freshwater. The area of interest where a diversion structure could be located occurs on the left descending bank of the Mississippi River, between White Ditch to the north (river mile 64.5) and the community of Phoenix to the south (river mile 59.8). This 4.7 mile stretch is unique in that there is no hurricane protection levee (back levee) on the marsh side that protects existing homes and infrastructure from elevated water levels (tidal or storm surge). The Mississippi River levee is the only flood protection structure that keeps river water from entering the project study area. This situation minimizes the amount of infrastructure that could be affected by construction of a diversion structure and allows for a broader array of measures to be considered in addressing problems in the project area.

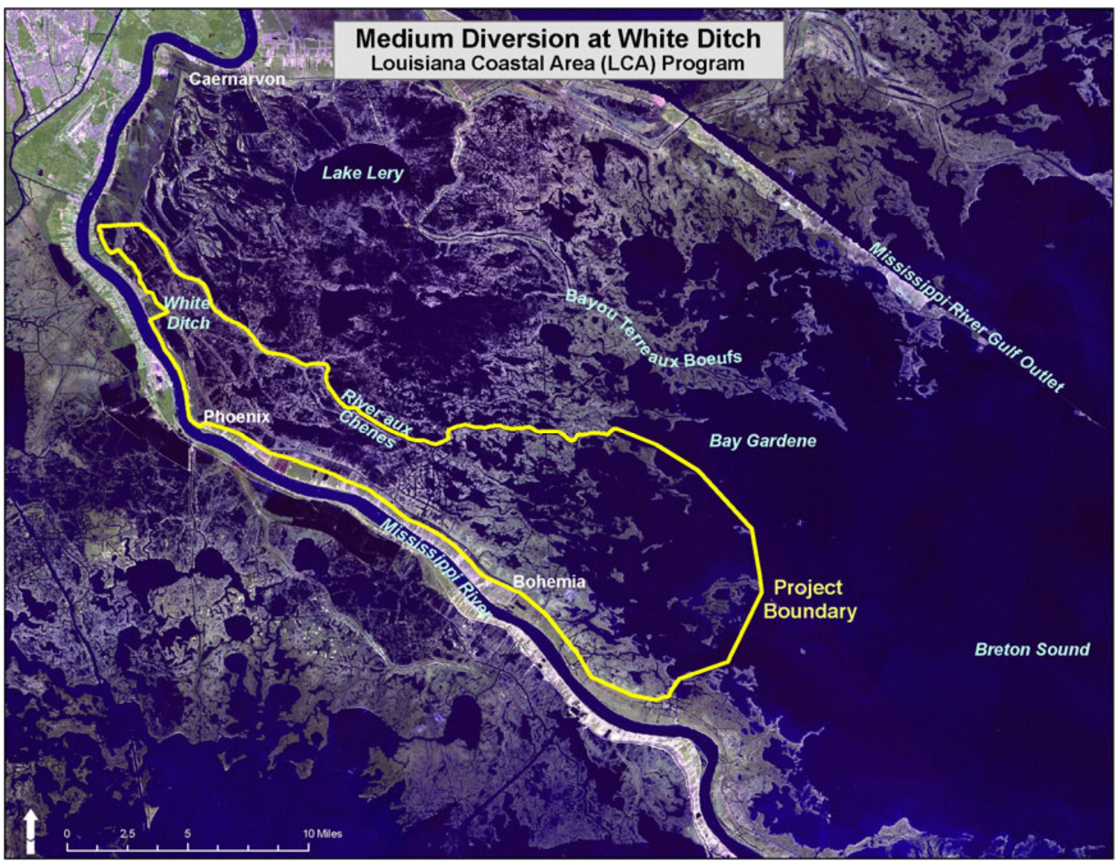

Figure 1: Study Area Map

Proposed Action

The tentatively selected plan proposes the construction of a medium sized diversion structure capable of diverting up to 35,000 cfs consisting of 10 15ft. x 15ft. box culverts with hydraulic operated sluice gates, and constructing an outfall channel to carry fresh water and sediment to the desired locations in the marsh. Additionally, there will be 32 acres of ridge and terrace creation and 385 acres of marsh creation utilizing dredged material from an adjacent 223 acres of canal being reconfigured to convey freshwater, nutrient and sediments.

The current operating plan for the tentatively selected plan at the White Ditch Diversion is limited to a diversion pulse of 35,000 cfs in March-April of each year, during the normal high flow period of the Mississippi River, and a diversion of 1,000 cfs the rest of the year. This flow rate may not be experienced over the full 60 day period. The proposed 35,000 cfs diversion will be the largest man-made diverted flow for wetland building on the Lower Mississippi River, but the one to two month duration will be a modifying factor. The diversion should approximate five percent or less of the main channel flow for most years.

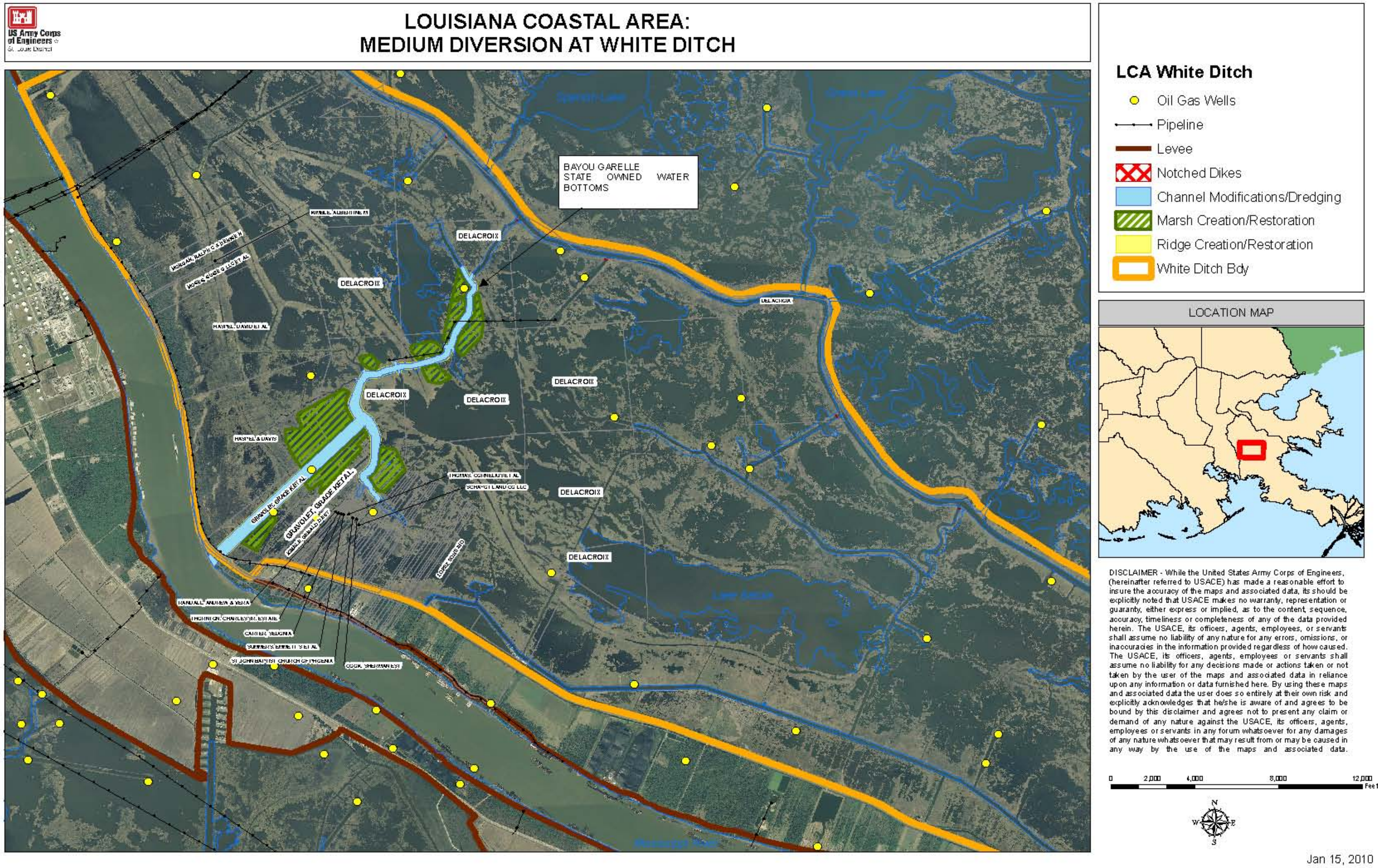

Figure 2: Proposed Medium Diversion at White Ditch

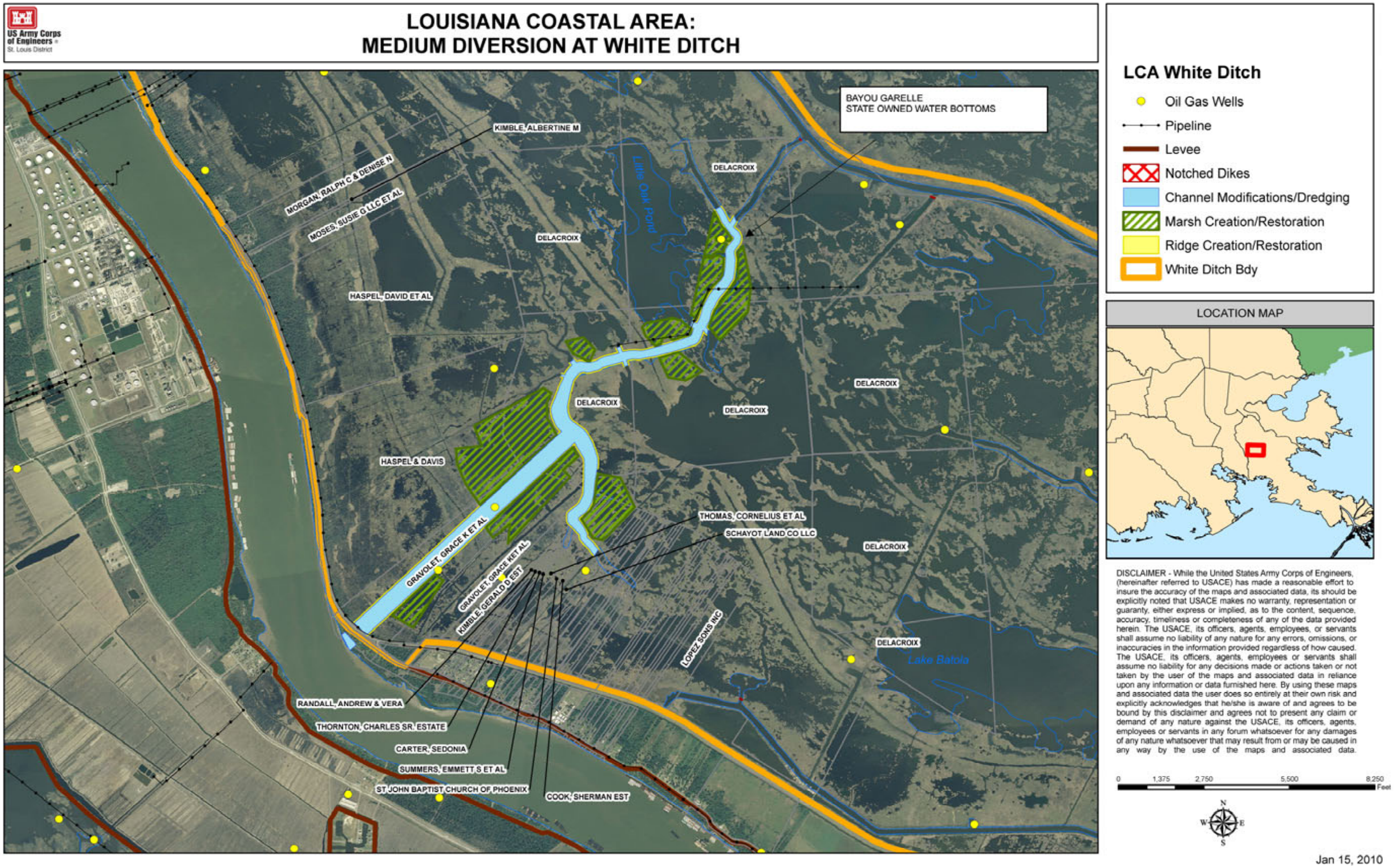

Figure 3: Map of Proposed Medium Diversion at White Ditch

Species Descriptions

Gulf Sturgeon (*Acipenser oxyrinchus desotoi*)

Status

The Gulf sturgeon was Federally listed as threatened throughout its range on September 30, 1991 and is also listed as a threatened species in Louisiana. The present range of the species extends from east of the Mississippi River in Louisiana east to the Suwannee River in Florida (USFWS and NMFS 2003).

Species and Habitat Description

Gulf sturgeon are light brown to dark brown in color with a pale underside (USFWS & Gulf States Marine Fisheries Commission, 1995). They have elongate, fusiform bodies covered by naked skin imbedded with bony plates or scutes. The average adult Gulf sturgeon ranges in size from 120-225 cm in length with an average weight between 35-320 lbs. The largest recorded Gulf sturgeon was caught at Cow Horn Reef near the mouth of the Mississippi in September 1936. Its reported mass was 228.2 kg with a length of 274 cm (Reynolds, 1993). Size is dependant on the individual's gender, age, and spawning condition (USFWS, 1980; Huff, 1975). Females live longer than males and continue to grow with age, consequently they are larger and weigh more than males (Huff, 1975). Females reach sexual maturity between 8 and 17 years of age while males reach sexual maturity between the ages of 7 to 21 (Huff, 1975). Gulf sturgeon are long lived, having the possibility of reaching at least 42 years old (Huff, 1975).

Gulf sturgeon live in the estuaries and coastal shelf regions of the Gulf of Mexico during the cooler months from October to March. In March and early April, adult sturgeon start their migration into the freshwater rivers in search of spawning habitat. Non-ripe adults, juveniles and subadults also participate in this yearly migration, but usually lag behind the spawning adults, moving into the rivers anywhere from days to months later. Sexually mature, ripe males and females enter the rivers when the surface water temperatures reach 62-70^{o} F (Carr, Tatman, & Chapman, 1996). Fox et al. (2002), in their studies of Gulf sturgeon in the Choctawhatchee Bay, found that male sturgeon enter the river earlier than female sturgeon and move greater distances upstream. Males were also found to remain at the spawning grounds longer than females. Ripe specimens of both sexes entered the Choctawhatchee River earlier and moved significantly further upstream than non-ripe fish. After spawning, both males and females return to the lower river reaches and join their non-spawning counterparts in summer holding areas where they reside until the fall migration. After hatching, age-0 fish remain in riverine habitats through January, moving into the estuaries in February as age-1 fish (Sulak et al., 1998).

Fall migration after spawning and river temperatures drive the return of sturgeon to the Gulf of Mexico. When river temperatures approximate the fall temperatures of the Gulf of Mexico (usually in late October or early November), and surface temperatures drop between 62-72^{o} F, sturgeon leave the rivers (Chapman, 2001; Foster & Clugston, 1997) for their winter marine habitats. Sulak et al. (1999) reported that adult Gulf sturgeon in the Suwannee River spend up to several weeks of pre-migratory staging (late November to early December) in the lower river and adjacent estuary. While it has been suggested that this kind of holding pattern prior to the sturgeon's movement between fresh and saline environments may be necessary due to osmoregulatory functions (Murphy & Skaines, 1994), some rivers, like the Pearl River, report sturgeon moving through the river/bay interface rapidly, requiring little if any time for acclimatization (Howard Rogillio, LDWF personal communication). Altinok et al. (1998) determined that, by age one, Gulf sturgeon have developed an active mechanism for osmoregulation and ion balance in euryhaline environments.

Distribution of Gulf sturgeon in Louisiana extends from the Mississippi River east to the Pearl River. The majority of these sturgeon have their origins in the Pearl River system, where the largest population occurs. However, Gulf sturgeon have historically inhabited many of the larger tributaries east of the Mississippi River, including some upstream of the Ross Barnett Dam (Morrow et al., 1996). As a result of the channelization of the Mississippi River through its extensive lock and levee system, any spawning habitat that may have existed in the Mississippi River for Gulf sturgeon has since been severely degraded. There is no evidence indicating a reproducing population in this river and no verified captures of Gulf sturgeon have occurred in the Mississippi River. The movements of foraging sturgeon along the coast may occasionally place them in the vicinity of the mouth of the Mississippi. At present there is no critical habitat identified in this area for Gulf sturgeon.

The Gulf sturgeon, *Acipenser oxyrinchus desotoi* (Vladykov, 1955), is a separate subspecies of the Atlantic sturgeon, *Acipenser oxyrinchus oxyrinchus*. Gulf sturgeon differ from their Atlantic counterparts in relative head length, pectoral fin lengths, dorsal scute shape, as well as spleen length and position. In 1996, Ong et al. presented genetic evidence that Atlantic and Gulf sturgeon are different species using direct sequence analysis of the mitochondrial DNA control region. Gulf sturgeon are anadromous fish (migrating seasonally between fresh and saltwater) that range primarily from the Suwannee River in Florida to the Mississippi River in Louisiana (Morrow et al, 1996). Their distribution is limited to the Gulf of Mexico by the emergence of peninsular Florida, which led to the development of the separate species. This speciation is maintained by the thermal barrier of the Gulf Stream around south Florida (Huff, 1975). Similarly, the Mississippi River also appears to limit their movements in the Gulf of Mexico to east of the Mississippi River.

Management and Protection

Historically, Gulf sturgeon have supported both commercial and recreational fisheries throughout most of their range from the Mississippi River east to Tampa Bay (U.S. Commission of Fish and Fisheries, 1902, cited in Wooley and Crateau, 1985). Large-scale exploitation of Gulf sturgeon began around 1860, when it was discovered that smoked sturgeon could be substituted for smoked halibut and that Gulf sturgeon eggs could be made into high-quality caviar (Smith, 1990). Sturgeon have been harvested with gillnets, pound nets, otter trawls, harpoons, trammel nets, weirs, stake row nets, and seines (Huff, 1975; Smith, 1985; Van Den Avyle, 1984; Smith & Clugston, 1997). Gulf sturgeon populations have declined due to fisheries over-exploitation (Barkuloo, 1988), spawning habitat loss via dam construction, and deterioration of water quality in their natal rivers (Morrow et al., 1996). Sturgeon are particularly vulnerable to gill net fisheries and are also found in the bycatch of shrimp trawls. Turtle excluder devices (TEDs) are thought to reduce sturgeon bycatch, though, to date no studies have been conducted to specifically evaluate this possibility. Even though sturgeon fishing regulations are in place, poaching of Gulf sturgeon still occurs (Collins et al., 2000). Restrictions applied to the sturgeon fisheries have not resulted in the restoration of population size. This may be due to the reduction of suitable spawning habitat. Poss (1998) notes that dredging operations reduce the deeper holes and hard substrate sturgeon require for spawning. Dams and low water sills prevent the movement of spawning adults to traditional spawning grounds. Low dissolved oxygen levels from eutrophication also contribute to spawning habitat degradation. Adults and subadults are not greatly affected by changes in salinity, dissolved oxygen, or high temperatures, however, eggs and larval stages of the sturgeon have low tolerance ranges for these criteria (Collins et al., 2000).

On March 19, 2003, the USFWS and NOAA Fisheries published a final rule in the Federal Register (Volume 68, No. 53) designating critical habitat for the Gulf sturgeon in Louisiana, Mississippi, Alabama, and Florida. Portions of the Pearl and Bogue Chitto Rivers, Lake Pontchartrain east of the Lake Pontchartrain Causeway, all of Little Lake, The Rigolets, Lake St. Catherine, and Lake Borgne within Louisiana were included in that designation, see Figure 4. The proposed MDWD falls well outside of this habitat designation. None of the primary constituent elements that are necessary to ensure the survival of the species currently exist within the proposed project area. With the implementation of the project, improvements in the hydrology and habitat within the area may begin to support some of these functions and possibly may improve habitat on the eastern Louisiana coast.

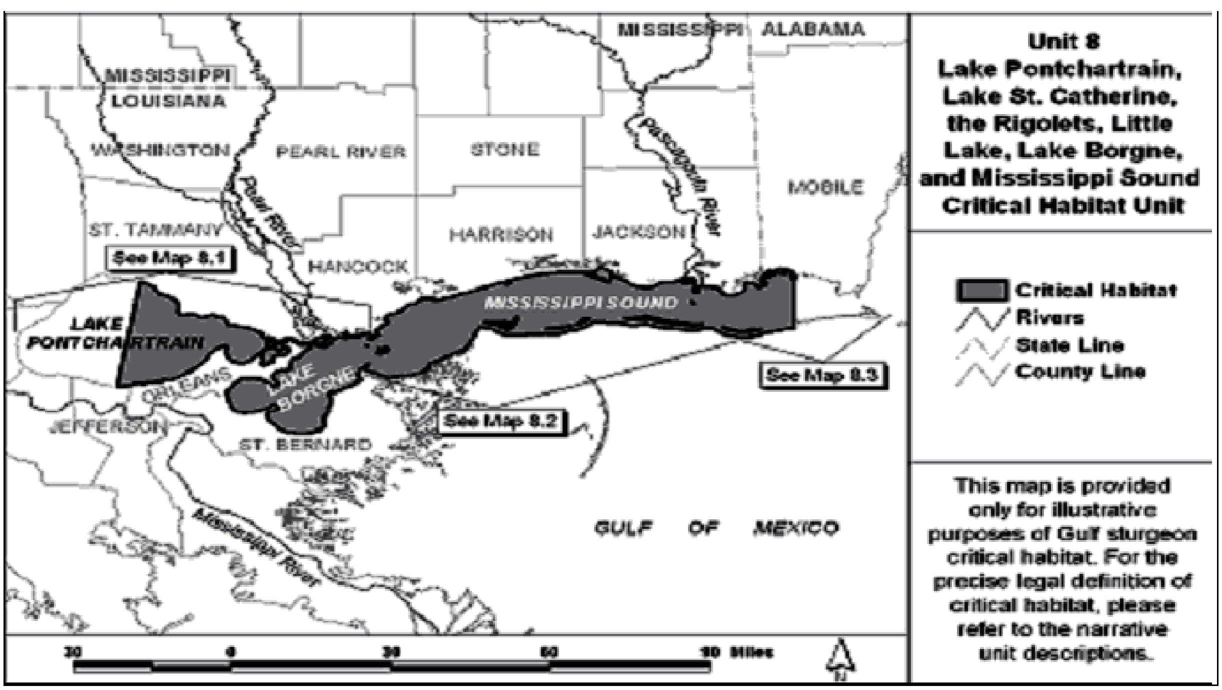

Figure 4: Louisiana Estuarine Critical Habitat

Green Sea Turtle (*Chelonia mydas*)

Status

The green sea turtle was listed as threatened in U.S. waters, except for the Florida breeding population which is listed as endangered, on July 28, 1978. Due to the inability to distinguish between these populations away from the nesting beach, green turtles are considered endangered wherever they occur in U.S. waters. Commercial harvest, habitat degradation, coastal development, disease, and predation have all contributed to the decline of the species.

Species and Habitat Description

The green sea turtle is one of the largest marine turtles with adult weights averaging between 250 to 450 pounds (Dundee 1989). This species can live upwards of 50 years and usually reaches sexual maturity between ages 20-50 years. The green sea turtle is considered to be unique in regards to other sea turtles in that it is mostly herbivorous in its adult stage typically feeding on underwater vegetation and algae (NOAA-1). On occasion, adult green sea turtles have been known to eat carrion and other marine invertebrates such as jellyfish (LDWF-2 & Dundee 1989). During the yearling stages, the species lives in and around offshore areas and its diet is primarily carnivorous (NOAA-1). In the Atlantic and Gulf of Mexico waters, the green sea turtle typically inhabits areas adjacent to the coastline and has been known to have a range spanning from Texas to as far north as Massachusetts. There are three types of environments that this species is known to inhabit: oceanic beaches generally used for nesting; convergence zones in the open ocean; and benthic feeding grounds in coastal areas (NOAA-1). In 1998, critical habitat for this species was designated in and around the Culebra Islands, which are situated off the eastern coast of Puerto Rico (NMFS 1998). One of the greatest impacts to this species has been the harvest of eggs, juveniles and adults on both nesting and feeding grounds. Additional threats, specifically in the U.S., include the erosion of the coastline and the barrier islands, which results in the loss of suitable habitat for this species (LDWF-2). Fishing and dredging operations, specifically hopper-type dredges, have also adversely impacted this species throughout the years.

In the western Atlantic, several major nesting assemblages have been identified and studied (Peters, 1954; Carr and Ogren, 1960; Parsons, 1962; Pritchard, 1969; Carr *et al*., 1978). In the continental United States, green turtle nesting occurs on the Atlantic coast of Florida (Ehrhart, 1979). Occasional nesting has been documented along the Gulf coast of Florida, at Southwest Florida beaches, as well as the beaches on the Florida Panhandle (Meylan *et al., 1995*). Most documented green turtle nesting activity occurs on Florida index beaches, which were established to standardize data collection methods and effort on key nesting beaches. The pattern of green turtle nesting shows biennial peaks in abundance, with a generally positive trend during the six years of regular monitoring since establishment of the index beaches in 1989, perhaps due to increased protective legislation throughout the Caribbean (Meylan *et al.*, 1995).

While nesting activity is obviously important in identifying population trends and distribution, the majority portion of a green turtle's life is spent on the foraging grounds. Green turtles are herbivores, and appear to prefer marine grasses and algae in shallow bays, lagoons and reefs (Rebel, 1974). Some of the principal feeding pastures in the Gulf of Mexico include inshore south Texas waters, the upper west coast of Florida and the northwestern coast of the Yucatan Peninsula. Additional important foraging areas in the western Atlantic include the Indian River Lagoon System in Florida, Florida Bay, the Culebra archipelago and other Puerto Rico coastal waters, the south coast of Cuba, the Mosquito coast of Nicaragua, the Caribbean coast of Panama, and scattered areas along Colombia and Brazil (Hirth, 1971). The preferred food sources in these areas are *Cymodocea, Thalassia, Zostera, Sagittaria, and Vallisneria* (Babcock, 1937; Underwood, 1951; Carr, 1952; 1954).

Management and Protection

Green turtles are distributed circumglobally, mainly in waters between the northern and southern 20^{o} C isotherms (Hirth, 1971). Green turtles were traditionally highly prized for their flesh, fat, eggs, and shell, and fisheries in the United States and throughout the Caribbean are largely to blame for the decline of the species. Green turtles were once abundant enough in the shallow bays and lagoons of the Gulf to support a commercial fishery, which landed over one million pounds of green turtles in 1890 (Doughty, 1984). Doughty (1984) reported the decline in the turtle fishery throughout the Gulf of Mexico by 1902. Currently, green turtles are uncommon in offshore waters of the northern Gulf, but abundant in some inshore embayments. Shaver (1994) live-captured a number of green turtles in channels entering into Laguna Madre, in south Texas. She noted the abundance of green turtle strandings in Laguna Madre inshore waters and opined that the turtles may establish residency in the inshore foraging habitats as juveniles. Algae along the jetties at entrances to the inshore waters of south Texas was thought to be important to green turtles associated with a radio-telemetry project (Renaud *et al*., 1995). Transmitter-equipped turtles remained near jetties for most of the tracking period. This project was restricted to late summer months, and therefore may reflect seasonal influences. Coyne (1994) observed increased movements of green turtles during warm water months.

In the Southeast United States, major nest protection efforts and beach habitat protection are underway for most of the significant nesting areas, and significant progress has been made in reducing mortality from commercial fisheries in U.S. waters with the enforcement of TED regulations. Many coastal counties and communities in Florida have developed lighting ordinances to reduce hatchling disorientations. Important U.S. nesting beaches have been and continue to be acquired for long-term protection. The Fish and Wildlife Service and National Marine Fisheries Service have been funding research on the fibropapilloma disease for several years to expand our knowledge of the disease with the goal of developing an approach for remedying the problem. Due to the long range migratory movements of sea turtles between nesting beaches and foraging areas, long-term international cooperation is absolutely essential for recovery and stability of nesting populations (USFWS North Florida Fact Sheet).

Kemp's Ridley Sea Turtle (*Lepidochelys kempii*)

Status

The Kemp's ridley sea turtle was listed as endangered throughout its range on December 2, 1970. Commercial harvest, habitat degradation, coastal development, disease, and predation have all contributed to the decline of the species.

Species and Habitat Description

Of the seven extant species of sea turtles of the world, the Kemp's ridley has declined to the lowest population level. Kemp’s ridleys nest in daytime aggregations known as arribadas, primarily at Rancho Nuevo, a stretch of beach in Mexico. Most of the population of adult females nest in this single locality (Pritchard, 1969). When nesting aggregations at Rancho Nuevo were discovered in 1947, adult female populations were estimated to be in excess of 40,000 individuals (Hildebrand, 1963). By the early 1970s, the world population estimate of mature female Kemp's ridleys had been reduced to 2,500-5,000 individuals. The population declined further through the mid-1980s. Recent observations of increased nesting, suggest that the decline in the ridley population has stopped, and there is cautious optimism that the population is now increasing.

The Kemp’s ridley sea turtle is the smallest of the sea turtles with adults reaching an approximate length of 2 to 2 ½ feet and weighing around 110 pounds (Dundee 1989). This species has a single claw located on its front flippers and usually has one to two claws located on its rear flippers (NOAA-3). The species’ is carnivorous and usually feeds upon crabs, clams, and snails that inhabit the shallow coastal waters (Dundee 1989). During the months of May to October, this species can be found in and around the shore line of Louisiana with adults occupying areas around the mouth of Mississippi during the spring and summertime. As winter approaches, adults and juveniles generally head to warmer waters offshore. The Kemp’s Ridley sea turtle’s habitat is comprised of warm bays, coastal waters, sea grass beds, and sandy beaches utilized for nesting (LDWF-4). This species has been observed within the Sabine and Calcasieu Lakes as well as in Lake Borgne and areas around St. Bernard Parish (Dundee 1989). Similar to other sea turtles, threats to this species include the harvest of eggs and nesting adults, incidental trapping in fishing nets, and loss of suitable habitat. It has been suggested that sea turtles may burrow into the estuarine mud along the Gulf coast during the winter, essentially when water temperatures are too low for normal activity, but no dormant sea turtles have been reported in coastal Louisiana.

The nearshore waters of the Gulf of Mexico are believed to provide important developmental habitat for juvenile Kemp's ridley and loggerhead sea turtles. Ogren (1988) suggests that the Gulf coast, from Port Aransas, Texas, through Cedar Key, Florida, represents the primary habitat for subadult ridleys in the northern Gulf of Mexico. Stomach contents of Kemp's ridleys along the lower Texas coast had a predominance of nearshore crabs and mollusks, as well as fish, shrimp and other foods considered to be shrimp fishery discards (Shaver, 1991). Analyses of stomach contents from sea turtles stranded on upper Texas beaches apparently suggest similar nearshore foraging behavior (Plotkin, pers. comm.).

Research being conducted by Texas A&M University at Galveston has resulted in the intentional live-capture of 516 sea turtles from 1991-1997. Green turtles comprise over 95% of all sea turtle captures recorded by Texas A&M researchers from South Padre/Laguna Madre studies. Conversely, the Kemp’s ridley dominates (92.2%) captures from more turbid, blue-crab laden waters of the upper Texas and Louisiana coasts. Capture statistics readily justify Sabine and Calcasieu Passes being considered “index habitat” for the Kemp’s ridley (Landrey et al., 1997).

The Texas A&M University research has resulted in the live-capture of 100s of Kemp’s ridleys at Sabine Pass and the entrance to Galveston Bay. Between 1989 and 1993, 50 of the Kemp's ridleys captured were tracked by biologists with the NMFS Galveston Laboratory using satellite and radio telemetry. The tracking study was designed to characterize sea turtle habitat and to identify small and large scale migration patterns. Preliminary analysis of the data collected during these studies suggests that subadult Kemp's ridleys stay in shallow, warm, nearshore waters in the northern Gulf of Mexico until cooling waters force them offshore or south along the Florida coast (Renaud, NMFS Galveston Laboratory, pers. comm.).

Seasonal abundance of sea turtles utilizing nearshore waters of the northwest Gulf of Mexico varies with species and location. Kemp’s ridleys are transient users of the coastal zone who venture toward tidal passes and into bays during May-August when food sources and other environmental factors are favorable. The May-August period has yielded over 80% of the sea turtle captures (N=516) recorded by Texas A&M researchers, over 75% of which were Kemp’s ridleys (Landry *et al*., 1997).

Management and Protection

The recent nesting increase can be attributed to full protection of nesting females and their nests in Mexico, and the requirement to use turtle excluder devices in shrimp trawls both in the United States and Mexico. In 1966, conservation efforts for the Kemp’s ridley were initiated on the beach near Rancho Nuevo in Tamaulipas, Mexico. This locale is the only place in the world where large nesting aggregations of this sea turtle were and are known to occur. From 1966 to 1987, conservation efforts focused on the area of Rancho Nuevo with one turtle protection camp. In 1978, the U.S. joined with Mexico at Rancho Nuevo in a bi-national effort to prevent the extinction of the Kemp’s ridley. In 1988, this bi-national program expanded to the south and another camp was added. In 1989, a third camp was established when the program was expanded to the north of Rancho Nuevo. By 1997, a total of seven camps had been established along the Tamaulipas and Veracruz coasts to allow for increased nest protection efforts (USFWS North Florida Fact Sheet).

The Mexico government also prohibits harvesting and is working to increase the population through more intensive law enforcement, by fencing nest areas to diminish natural predation, and by relocating all nests into corrals to prevent poaching and predation. While relocation of nests into corrals is currently a necessary management measure, this relocation and concentration of eggs into a "safe" area is of concern since it makes the eggs more susceptible to reduced viability due to movement-induced mortality, disease vectors, catastrophic events like hurricanes, and marine predators once the predators learn where to concentrate their efforts (USFWS North Florida Fact Sheet).

In recent years, unprecedented numbers of Kemp's ridley carcasses have been reported from Texas and Louisiana beaches during periods of high levels of shrimping effort. NMFS established a team of population biologists, sea turtle scientists, and managers, known as the

Expert Working Group (EWG) to conduct a status assessment of sea turtle populations. Analyses conducted by the group have indicated that the Kemp's ridley population is in the early stages of recovery; however, strandings in some years have increased at rates higher than the rate of increase in the Kemp's population (Expert Working Group, June 1996). While many of the stranded turtles observed in recent years in Texas and Louisiana are believed to have been incidentally taken in the shrimp fishery, other sources of mortality exist in these waters. These stranding events illustrate the vulnerability of Kemp's ridley and loggerhead turtles to the impacts of human activities in nearshore Gulf of Mexico waters.

The EWG developed a population model to evaluate trends in the Kemp's ridley population through the application of empirical data and life history parameter estimates chosen by the EWG. Model results identified three trends in benthic immature Kemp's ridleys. Benthic immatures are those turtles that are not yet reproductively mature but have recruited to feed in the nearshore benthic environment, where they are available to nearshore mortality sources that often result in strandings. Benthic immature ridleys are estimated to be 2-9 years of age and 20-60 cm in length. Increased production of hatchlings from the nesting beach beginning in 1966 resulted in an increase in benthic ridleys that leveled off in the late 1970s. A second period of increase followed by leveling occurred between 1978 and 1989 as hatchling production was further enhanced by the cooperative program between the USFWS and Mexico's Instituto Nacional de Pesca (INP) to increase the nest protection and relocation program in 1978. A third period of steady increase, which has not leveled off to date, has occurred since 1990 and appears to be due to the greatly increased hatchling production and an apparent increase in survival rates of immature turtles beginning in 1990 due, in part, to the introduction of TEDs. Adult ridley numbers have now grown from a low of approximately 1,050 adults producing 702 nests in 1985, to greater than 3,000 adults producing 1940 nests in 1995 and about 3,425 nests in 1998.

The EWG was unable to estimate the total population size and current mortality rates for the Kemp's ridley population. However, they listed a number of preliminary conclusions. They indicated that the Kemp's ridley population appears to be in the early stage of exponential expansion. Over the period 1987 to 1995, the rate of increase in the annual number of nests accelerated in a trend that would continue with enhanced hatchling production and the use of TEDs. Nesting data indicated that the number of adults declined from a population that produced 6,000 nests in 1966 to a population that produced 924 nests in 1978 and a low of 702 nests in 1985. This trajectory of adult abundance tracks trends in nest abundance from an estimate of 9,600 in 1966 to 1,050 in 1985. The EWG estimated that in 1995 there were 3,000 adult ridleys. The increased recruitment of new adults is illustrated in the proportion of neophyte, or first time nesters, which has increased from 6% to 28% from 1981 to 1989 and from 23% to 41% from 1990 to 1994. The EWG's population model projected that Kemp's ridleys could reach the intermediate recovery goal identified in the Recovery Plan, of 10,000 nesters by the year 2020 if the assumptions of age to sexual maturity and age specific survivorship rates plugged into their model are correct. They determined that the data they reviewed suggested that adult Kemp's ridley turtles were restricted somewhat to the Gulf of Mexico in shallow near shore waters, and benthic immature turtles of 20-60 cm straight line carapace length are found in nearshore coastal waters including estuaries of the Gulf of Mexico and the Atlantic.

The EWG identified an average Kemp's ridley population growth rate of 13% per year between 1991 and 1995. Total nest numbers have continued to increase. However, the 1996 and 1997 nest numbers reflected a slower rate of growth, while the increase in the 1998 nesting level has been much higher. The population growth rate does not appear as steady as originally forecasted by the EWG, but annual fluctuations, due in part to irregular internesting periods, are normal for other sea turtle populations.

The area surveyed for ridley nests in Mexico was expanded in 1990 due to destruction of the primary nesting beach by Hurricane Gilbert. The EWG assumed that the increased nesting observed particularly since 1990 was a true increase, rather than the result of expanded beach coverage. Because systematic surveys of the adjacent beaches were not conducted prior to 1990, there is no way to determine what proportion of the nesting increase documented since that time is due to the increased survey effort rather than an expanding ridley nesting range. As noted by the EWG, trends in Kemp's ridley nesting even on the Rancho Nuevo beaches alone suggest that recovery of this population has begun but continued caution is necessary to ensure recovery and to meet the goals identified in the Kemp's ridley Recovery Plan.

Loggerhead Sea Turtle (*Caretta caretta*)

Status

The Loggerhead sea turtle was listed as endangered throughout its range on July 28, 1978. Commercial harvest, habitat degradation, coastal development, disease, and predation have all contributed to the decline of the species.

Species and Habitat Description

The threatened loggerhead is the most abundant species of sea turtle occurring in U.S. waters. The nearshore waters of the Gulf of Mexico are believed to provide important developmental habitat for juvenile loggerheads. Studies conducted on loggerheads stranded on the lower Texas coast (south of Matagorda Island) have indicated that stranded individuals were feeding in nearshore waters shortly before their death (Plotkin *et al.*, 1993).

The loggerhead sea turtle is also one the larger marine turtles with average adult lengths ranging from 3 to 7 feet and weighing approximately 300 to 1,100 pounds (Dundee 1989). This species usually reaches sexual maturity around age 35 and mating in the southeastern U.S. can occur between late March and early June. The habitat for loggerheads consists of three different zones throughout their lifetime: terrestrial zone, oceanic zone, and near shore or neritic zone (NOAA-5). The lifecycle of the loggerhead, from hatchling to adult, begins when hatchlings leave the ocean beach nesting site and migrate towards waters consisting of seaweed and sea grass cover. The juveniles head into the neritic zone during the ages of 7 to 12 and remain there maturing into adulthood. Coastal Areas not only provide an excellent food source for adults inhabiting the area, but they also allow for easy access to migratory routes (NOAA-5). Large nesting populations have been recorded along the coastal islands of the North and South Carolinas, Georgia, and the Gulf coasts of Florida. In Louisiana, this species has been found nesting on the Chandeleur Islands and Grand Isle in Terrebonne Parish (Dundee 1989). Threats to this species are fairly similar to threats posed other species of sea turtles, which include incidental trapping in fishing nets, coastal erosion resulting in loss of nesting habitat, and harvesting of eggs and juveniles (NOAA-5 & LDWF-6).

Management and Protection

In the Southeast United States, major nest protection efforts and beach habitat protection are underway for most of the significant nesting areas, and significant progress has been made in reducing mortality from commercial fisheries in U.S. waters with the enforcement of TED regulations. Many coastal counties and communities in Florida, Georgia, and South Carolina have developed lighting ordinances to reduce hatchling disorientations. Important U.S. nesting beaches have been and continue to be acquired for long-term protection. The migratory nature of loggerheads severely compromises these efforts once they move outside U.S. waters, however, since legal and illegal fisheries activities in some countries are causing high mortality on loggerhead sea turtle nesting populations of the western north Atlantic region. Due to the long range migratory movements of sea turtles between nesting beaches and foraging areas, long-term international cooperation is absolutely essential for recovery and stability of nesting populations (USFWS North Florida Fact Sheet).

The EWG identified four nesting subpopulations of loggerheads in the western North Atlantic based on mitochondrial DNA evidence. These include: (1) the Northern Subpopulation producing approximately 6,200 nests/year from North Carolina to Northeast Florida; (2) the South Florida Subpopulation occurring from just north of Cape Hatteras on the east coast of Florida and extending up to Naples on the west coast and producing approximately 64,000 nests/year; (3) the Florida Panhandle Subpopulation, producing approximately 450 nests/year; and (4) the Yucatan Subpopulation occurring on the northern and eastern Yucatan Peninsula in Mexico and producing approximately 1,500-2,000 nests/year.

Genetic analyses of benthic immature loggerheads collected from Atlantic foraging grounds identify a mix of the east coast subpopulations that is disproportionate to the number of hatchlings produced in these nesting assemblages. Although the northern nesting subpopulation produces only approximately 9% of the loggerhead nests, loggerheads on foraging grounds from the Chesapeake Bay to Georgia are nearly equally divided in origin between the two subpopulations (Sears, 1994; Sears *et al*., 1995; Norrgard, 1995). Of equal interest, 57% of the immature loggerheads sampled in the Mediterranean were from the South Florida Subpopulation, while only 43% were from the local Mediterranean nesting beaches (Laurent *et al*., 1993; Bowen, 1995). Genetic work has not yet been done on nesting or foraging loggerheads in the Gulf of Mexico.

The EWG considered nesting data collected from index nesting beaches to index the population size of loggerheads and to consider trends in the size of the population. They constructed total estimates by considering a ratio between nesting data (and associated estimated number of adult females and therefore adults in nearshore waters), proportion of adults represented in the strandings, and in one method, aerial survey estimates. These two methods indicated that for the 1989-1995 period, there were averages of 224,321 or 234,355 benthic loggerheads, respectively. The EWG listed the methods and assumptions in their report, and suggested that these numbers are likely underestimates. Aerial survey results suggest that loggerheads in U.S. waters are distributed in the following proportions: 54% in the southeast U.S. Atlantic, 29% in the northeast U.S. Atlantic, 12% in the eastern Gulf of Mexico, and 5% in the western Gulf of Mexico.

The EWG considered long-term index nesting beach datasets when available to identify trends in the loggerhead population. Overall, they determined that trends could be identified for two loggerhead subpopulations. The Northern Subpopulation appears to be stabilizing after a period of decline; the South Florida Subpopulation appears to have shown significant increases over the last 25 years suggesting the population is recovering, although the trend could not be detected over the most recent 7 years of nesting. An increase in the numbers of adult loggerheads has been reported in recent years in Florida waters without a concomitant increase in benthic immatures. These data may forecast limited recruitment to south Florida nesting beaches in the future. Since loggerheads take approximately 20-30 years to mature, the effects of decline in immature loggerheads might not be apparent on nesting beaches for decades. Therefore, the EWG cautions against considering trends in nesting too optimistically.

Briefly, the EWG made a number of conclusions regarding the loggerhead population. They concluded that four distinct nesting populations exist based on genetic evidence, although separate management is not possible because of insufficient information on the in-water distribution of each subpopulation. They concluded that the recovery goal of more than 12,800 nests for the Northern Subpopulation was not likely to be met. Currently, nests number about 6,200 and no perceptible increase has been documented. The recovery goal or "measurable increases" for the south Florida (south of Canaveral and including southwest Florida) appears to have been met, and this population appears to be stable or increasing. However, index nesting surveys have been done for too short a time; therefore, it is difficult to evaluate trends throughout the region. Recovery rates for the entire subpopulation cannot be determined with certainty at this time. However, caution is warranted because, although nesting activity has been increasing, catches of benthic immature turtles at the St. Lucie Nuclear Power Plant intake canal, which acts as a passive turtle collector on Florida's east coast, have not been increasing. The EWG recommended establishing index nest survey areas in the Gulf of Mexico to monitor those populations, which do not currently have recovery goals assigned to them.

Effects of Proposed Action

Gulf Sturgeon (*Acipenser oxyrinchus desotoi*)

Sturgeon have been collected in Breton Sound to the west and east of Mississippi River Gulf Outlet (MRGO), and in a lagoon and two bayous connected to the MRGO. The Breton Islands are very similar to the islands along the Mississippi Gulf Coast used by sturgeon to forage around during the winter. Several sonic tagged sturgeon have been recorded by LDWF's remote tracking system off the northern-most tip of Chandeleur Island in Breton Sound, LA. However, these fish are considered to be unverified cases since they were isolated recordings, with only one reading per fish, recorded by a multidirectional hydrophone. USACE ERDC biologists located one sonic tagged Gulf sturgeon in the MR-GO near Bayou La Loutre in January of 2005 during telemetry searches of the channel. The fish was tracked moving from the

MR-GO into the surrounding marshes before its signal was lost. Use of the MR-GO and its bar channel by Gulf sturgeon would most likely be during migration to and from their winter habitats and during their marine feeding period. The proposed MDWD project area is located to the south of these sightings. Since Gulf sturgeon begin their migration to spawning habitat in March and April, consideration was given to the possibility that the increase in freshwater flow (35,000 cfs during March and April) could attract the species to the project area. It is possible, though unlikely, that the freshwater flow from the diversion could confuse Gulf sturgeon. If a Gulf sturgeon was disoriented and did make its way to the structure, then there is a potential for a small population to miss the opportunity to spawn during a given year. It is unlikely any individual sturgeon that finds itself in this position would be at risk for increased mortality. After April, flow within the structure would return to 1,000cfs and it is assumed that an sturgeon within the area would return to deeper waters in Breton Sound or the Gulf. This purely hypothetical assumption is neither supported nor refuted by current literature searches. Due to the small amount of recent and confirmed occurrences of Gulf sturgeon in the project area, CEMVN foresees minimal likelihood of impact to Gulf sturgeon populations from the proposed MDWD and therefore concludes the MDWD project would not adversely affect the species.

Green Sea Turtle (*Chelonia mydas*)

Given the lack of extensive sea grass beds and the low incidence of sightings in the proposed project areas, adverse impacts to the green sea turtle population are not expected. Additionally, the use of a hydraulic cutterhead-type dredge is not known to take sea turtles. With the low risk of affects to green sea turtles from the MDWD project, CEMVN concludes that the MDWD project would not adversely affect the species.

Kemp's Ridley Sea Turtle (*Lepidochelys kempii*)

Impacts to Kemp's ridley sea turtle population should be negligible or non-existent. During March and April when the proposed MDWD project is flowing 35,000cfs though the structure Kemp's Ridley are not expected to be in the Louisiana coastal area. The potential temporary removal of food sources by dredging operations may cause the Kemp's ridley sea turtle to forage elsewhere along the Gulf coast until the area is re-colonized by prey species. Coastal erosion and habitat loss is one limiting factor for the successful recovery of sea turtle populations in the Louisiana coastal zone. Coastal restoration efforts such as the MDWD project, should prove to be beneficial to the Kemp's ridley sea turtle. After assessing the MDWD project area along with the needs of the Kemp's ridley sea turtle, CEMVN concludes that the MDWD project is not likely to adversely affect the species.

Loggerhead Sea Turtle (*Caretta caretta*)

Habitat in Louisiana that is suitable for Loggerheads to nest on is typically associated with that of barrier islands. CEMVN believes that the proposed action will only temporarily disrupt foraging loggerhead sea turtles that may be in the area. Coastal erosion and habitat loss is one limiting factor for the successful recovery of sea turtle populations in the Louisiana coastal zone. Coastal restoration efforts such as the MDWD project, should prove to be beneficial to the loggerhead sea turtle. As previously stated, the use of a hydraulic cutterhead-type dredge is not known to take sea turtles. After assessing the MDWD project area and the needs of the loggerhead sea turtle, CEMVN concludes that the MDWD project would not adversely affect the species.

Conclusion

Based on currently available historical and catch data, a review of current literature and studies, and with the employment of avoidance measures recommended through guidelines set up during coordination with NMFS, the CEMVN, believes that Gulf sturgeon and green, Kemp's ridley, and loggerhead sea turtles would not adversely affected from construction and operation of the MDWD in the project location detailed in this assessment.

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Appendix A-3

Biological Opinion
U.S. Fish and Wildlife Service

United States Department of the Interior

FISH AND WILDLIFE SERVICE
646 Cajundome Blvd.
Suite 400
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 Medium Diversion at White Ditch located in Plaquemines Parish, 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 14, 2010, request for formal consultation was received on May 17, 2010. Additional information necessary to initiate consultation was provided by letter dated July 15, 2010, and received in this office on July 19, 2009.

This biological opinion (BO) is based on information provided in the May 14, 2010, biological assessment (BA), the July 15, 2010, letter providing supplemental information, the subsequent telephone conversation of August 27, 2010, regarding reasonable and prudent measures and methods for estimation of take, electronic 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: 43440-2009-F-3314
Date Started: May 14, 2010 **Ecosystem**: Lower Mississippi River
Action Agency: U.S. Corps of Engineers, New Orleans District
Project Title: Medium Diversion at White Ditch
County: Plaquemines Parish

The biological assessment (BA) was sent to us by members of the Army Corps of Engineers (Corps) on May 14, 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 1, 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 Medium Diversion at White Ditch and its possible affects on the pallid sturgeon was received on July 15, 2010. An electronic mail exchange between the Service and the Corps occurred on July 16, 2010, on three different methods that could be used to estimate take.

August 18, 2010, an e-mail was sent out by the Service to members of the Corps 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 of the Corps 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**
Piping Plover	*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

Freshwater diversions have been an important tool to combat land loss along the coast of Louisiana.

Six spillways, diversions and siphons have been built, namely the Bonnet Carre Spillway (Rmi 160), Davis Pond diversion (Rmi 119), Violet Siphon (Rmi 83), Naomi siphon (Rmi 63), the White Ditch siphon (Rmi 64) and Caernarvon diversion (Rmi 81). Some of these have resulted in benefits to the marshes near the outfall areas; therefore, four more are being proposed including the diversion at White Ditch (Figure 1). The Violet and White Ditch siphons have the capacity of diverting up to 200 cfs with Naomi diverting up to 1,500 cfs. The diversions generally carry a much larger amount of water with Caernarvon having the capacity to carry up to 8,000 cfs and Davis Pond has the capacity to carry 10,650 cfs. The Bonnet Carre Spillway was designed for flood control and not marsh creation and has a far larger capacity at around 250,000 cfs.

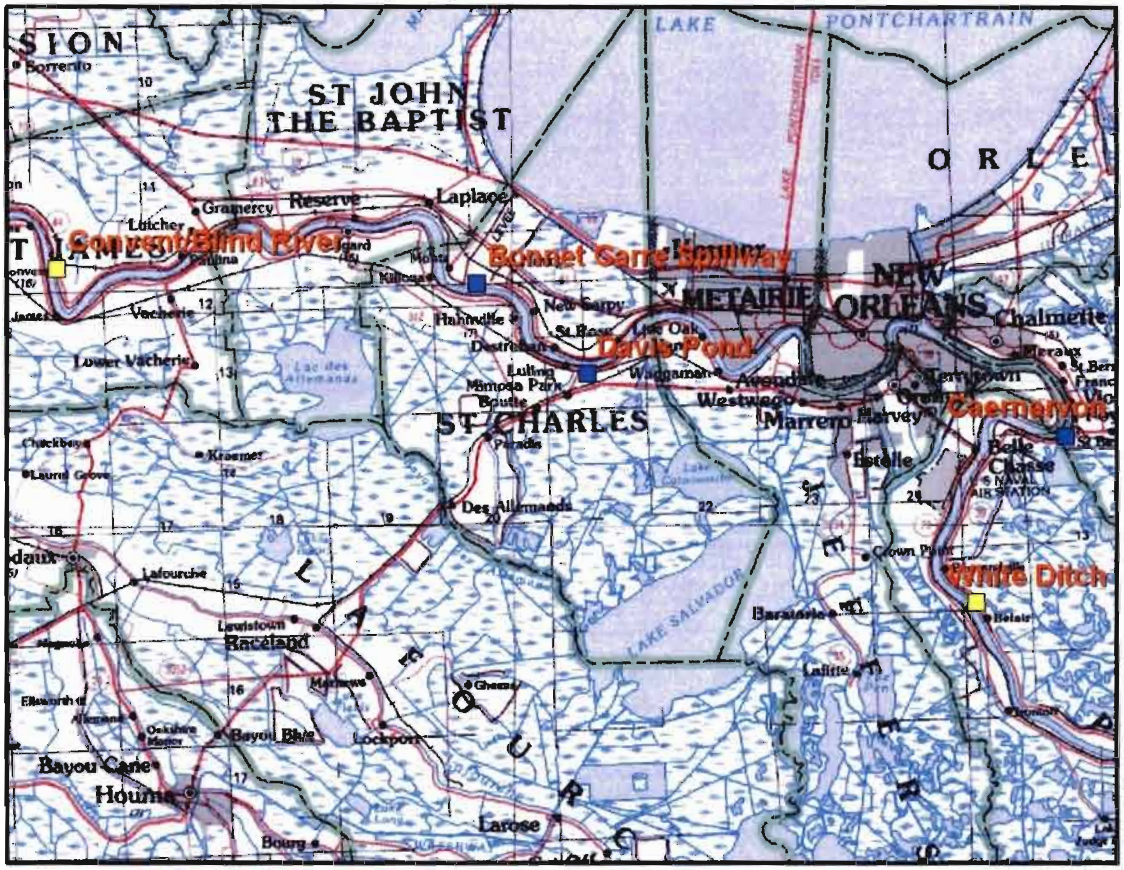


Figure 1. Existing and proposed diversions referenced in this document. The blue markers denote existing diversions while the yellow marks denote the proposed projects.

The Medium Diversion at White Ditch project (MDWD) is located between Mississippi River Miles 64.5 and 59.8 in the LCA subprovince 1 of Breton Sound in Plaquemines Parish, Louisiana. The influence area encompasses over 98,000 acres of intermediate and brackish intertidal wetlands that are home to a myriad of species of varying life stages. The boundaries are defined by the river Aux Chenes to the northeast and the levees along the left descending bank of the Mississippi River and extend out into Breton Sound (Figure 2). The Authorization for the project comes from Title VII of the Water Resources Development Act (WRDA) 2007 authorizes the Louisiana Coastal Area (LCA) ecosystem restoration program.

Degradation of the marsh has occurred over several years because of channel construction and levee construction reducing the natural over-topping of the river banks and resulting in altered hydrologic conditions. These changes in water regime have made the marsh more susceptible to storm damage, subsidence, soil erosion, and salt water intrusion. The White Ditch siphon at Rmi 64 (3 miles south of Belair, Louisiana) off the east descending bank of the Mississippi River was completed in 1963 for the purpose of increasing oyster and muskrat habitat by providing freshwater inputs during high water. However, no operational plan was put in place and thus the benefits of the siphon were limited. The siphon fell into disrepair and was only recently refurbished for research purposes. The proposed diversion will have a more controlled redirection of Mississippi River water into the marsh reducing salinity and increasing sediment inputs which should result in a more natural hydrologic condition.

The purpose of the proposed project is to restore freshwater and sediment inputs into this area of degraded marsh in the Breton Sound by diverted a large amount of Mississippi River water in the Marshes of the Breton Sound. Additionally, 31 acres of ridges will direct incoming water, and 385 acres of marsh will be created from the material removed from the 223 acre outfall canal. The constructed outfall channel would be approximately 7,200 feet long from the structure to Bayou Garelle. The intake and outfall channel would be dredged to a depth of -16 ft (NAVD) with a side slope ratio of 1:5. Bottom widths of the intake and out fall channels would be 365 ft and top widths would be 545 ft. The MDWD would be capable of diverting up to 35,000 cfs (4 percent of the rivers flow) through 10 15ft x15ft box culverts that could be opened and closed via hydraulic sluice gates (See appendix for engineering design of the control structure). This flow is at least 3 times that of the Davis Pond diversion and 4 times that of Caernarvon diversion. The current operational plan would take advantage of high river stages and high sediment loads in the spring and direct an annual spring pulse between March and April of the maximum 35,000 cfs followed by maintenance flow of 1,000 cfs for the remaining period of the annual cycle. This spring pulse plan was devised from data gathered from the Caernarvon Diversion which shows that some negative effects can occur from over-freshening the marshes during sensitive periods in the life cycles of marsh species. Though it has been noted in the Preliminary Draft Feasibility Study/SEIS that the effects of the White Ditch diversion will be monitored over time and adaptive management will be utilized to maximize benefits. The diversion is estimated to be 5 percent or less of the Mississippi River annual flow for most years.

Several locations for the structure were considered for the proposed White Ditch project and it was decided that the most cost effective plan would be to build the structure and channel somewhere between the existing White Ditch siphon (Rmi 64) and the town of Phoenix (Rmi 58.8) because of the lack of structures and a backing levee. The bend a few miles north of Phoenix (Figure 3.) was selected because of the build up of sediment forming a point bar in this location meant that a higher sediment load than other locations would be available for diversion through the structure. This is not the same location as the existing White Ditch Siphon and no other structures exist in the selected location which means that marsh will have to be excavated to build the outfall channel.

Figure 2. Map of the White Ditch project area

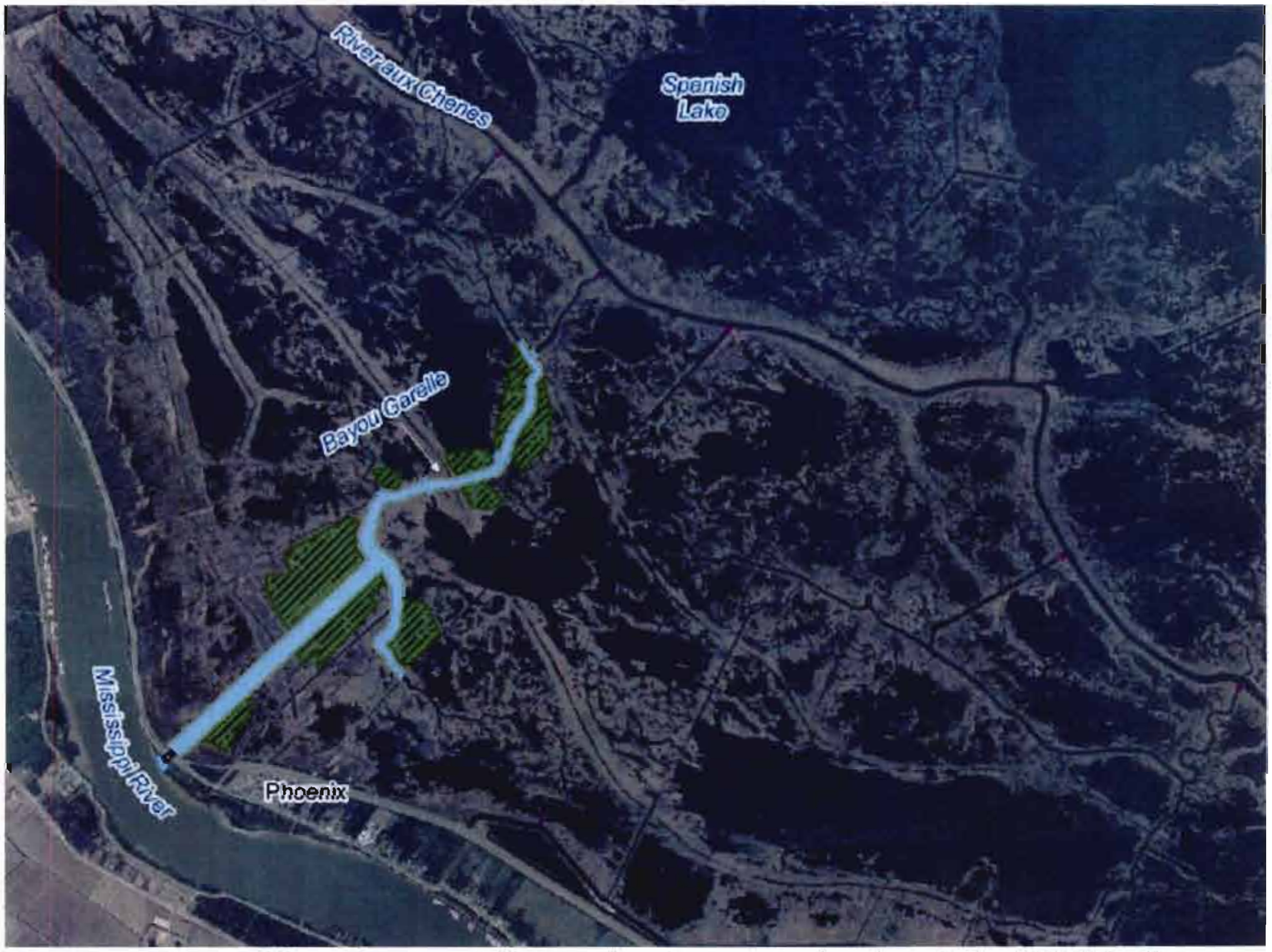


Figure 3. Close up of the project area with an outline the tentatively selected plan (TSP) for the conveyance channel to be constructed and the bordering areas of marsh creation (in green).

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.

Analysis of the species/critical habitat likely to be affected

The action under consideration is the construction and operation of the Medium Diversion at White Ditch. This opening will allow Mississippi River waters to flow through the control structure and into an outfall channel leading to ponds and marsh habitat. 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. The salt water wedge that may occur seasonally because of channel alterations may also affect pallid sturgeon in the action area. A constructed sill to reduce salt water intrusion has been constructed at Rmi 64 which is above the tentatively selected location of the proposed diversion at White Ditch. It is unclear to what extent salt water deters pallid sturgeon.

EFFECTS OF THE ACTION

This section includes an analysis of the direct and indirect effects of the proposed action on the species and/or its critical habitat and its interrelated and interdependent activities.

Factors to be considered

The proposed medium diversion at White Ditch is planned to be operated continuously between March and April each year (a total of 61 days). 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 for the full 60 days (approximately 16 percent of the year) that the diversion is completely open with maintenance flows of less than 1,000 cfs occurring the rest of the year. 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.

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 (35,000 cubic feet per second) could be up 700,000 cubic feet per second therefore, the maximum diversion flow represents approximately 2.5-4 percent of the flow in the river. For the range of river stages from 4 to 11 feet, the cross section of the diversion culverts (2,250 square feet at maximum capacity) is approximately 1 percent of the Mississippi River's cross section. At a stage of 11 the river at it deepest point is 130 feet.

The constructed outfall channel would be approximately 7,200 feet long from the structure to Bayou Garelle. The intake and outfall channel would be dredged to a depth of -16 ft (NAVD) with a side slope ratio of 1:5. Bottom widths of the intake and out fall channels would be 365 ft and top widths would be 545 ft. Average velocities in the White Ditch conveyance channel would likely be approximately 4 fps which in studies, has shown to the upper limit of sturgeon swimming capabilities; although, velocities in the Mississippi River at Phoenix are between 4 and 6 fps. The highest velocities would occur within the culverts during maximum diversion capacity, however, with velocities exceeding 15 fps. Maintenance flows would likely produce velocities in the culverts between 5 and 10 fps. 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 gates of 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 sturgeons 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 confounded this 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 as well as the loss of the point sand bar habitat that is located at the site of the proposed diversion which could potentially serve as a feeding site for pallid sturgeon. Entrainment behind diversions could mean the death of several individuals due to lack of the adequate pallid sturgeon habitat in the outfall channel and in the ponding area that is needed to feed, spawn, or carry out any other necessary life processes.

Indirect effects could be associated with the future loss of progeny from immature sturgeon that would never spawn. In other words, individuals who perish in the ponding area would be completely removed from the spawning populations in the lower Mississippi River, thus, impacting future populations. Other individuals who manage to survive in the channel would still be effectively removed from the spawning population as long as they remain behind the structure. The diversions are not anticipated to adversely impact water quality or any habitat utilized by pallid sturgeon for spawning or nursery.

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

No larval or young-of year (YOY) *Scaphirhynchus* were collected by Nichols State University 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 than previously though abundance (Constant et al. 1997, ERDC 2010; See also Age, Growth and Reproduction).

Kynard et al. (2002) and Braaten et al. (2008) reported longer larval drift times, thus greater distances traveled by pallid sturgeon larva when compared to shovelnose larva. 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 (River Mile 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 cubic feet per second (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. If the most southern pallid sturgeon spawning sites are the previously hypothesized gravel bars located in the vicinity of Vicksburg (River Mile 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 the 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 that 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 (gears they would be susceptible to were utilized) possibly indicates that those that were entrained they 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 stages. 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 Engineering Research and Development Center (ERDC) (2010) found that the lowest 70 miles of the Mississippi River where the proposed White Ditch Diversion will be located did not produce any sturgeon, though the Rmi 70- 100 section produced three shovelnose and 1 pallid. Sampling efforts in these two sections were lower than the sampling efforts put forth in the higher sections of the river. Sampling at Caernarvon (Rmi 81) by Nicholls State also did not produce any sturgeon. Sampling will continue as river stages are safe enough to utilize trotlines and trawls. Sampling from July 2009 to June 2010 by Nicholls State University in the Davis Pond Outfall Canal captured 3 shovelnose sturgeon and one pallid. The Davis Pond (Rmi 119) Freshwater Diversion can discharge up to 10,650 cfs.

Sturgeon swimming burst speeds may allow them to swim against the velocities in the structure at the maintenance level at lower river stages. Burst speeds, however, cannot be maintained for long distances and the length of the culvert is approximately 434 feet. Therefore, any sub-adult or adult sturgeon that are entrained may only have a very small 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.

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.
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.

The Service calculated the maximum take of 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 (9.472×10^{10} cubic ft) was divided by the estimated number of pallid entrained (i.e., 10) to determine the amount of volume discharged per each entrained fish (9.472×10^{9} cubic ft).

$(9.472x\ 10^{10}$ cfs)/10 entrained pallid sturgeon = 1 pallid sturgeon entrained per $9.472x\ 10^{9}$ cf

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., 1.84×10^{11} cubic ft). This total volume was divided by the volume of water discharged per each entrained fish (9.472×10^{9} cubic ft) to calculate the possible maximum number of fish entrained.

35,000 second-day-feet x 61 days x 86400 seconds per day + 1,000 second-day-feet x 304 days x 86400 seconds per day = $1.84 \times 10^{11} + 2.63 \times 10^{10}$
= 2.11×10^{11} cfs diverted in 1 year
2.11×10^{11} cfs /9.472×10^{9} cfs = 22.25 fish per year (rounded to 23)

The Corp is required to analyze projects impacts and benefits over a project life of 50 years. It is estimated that 1150 pallid sturgeon would be entrained over the project life of the proposed White Ditch diversion.

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., 2007a, Morrow et al., 1998) to determine the likelihood that the 2008 Bonnet Carre opening jeopardized the continued existence of the pallid sturgeon. The Service will reutilize this examination to aid in this impact determination.

The Service recognizes behavioral and biological differences in all life stages between the two species but also recognizes that similarities 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., (2007a) 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, it was felt that examination of the range of cohorts that would be impacted by past diversions may reveal any significant impacts even though the small number of sturgeon in those cohorts may make such an investigation tenuous. Cursory examination of age frequency by Killgore et al., (2007a) 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) 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 5; see date below figure explanation). However, examination of the cohort that would have been affected 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 affected the 1983 year class but overall any effect does not appear to have impacted future cohort abundance.

Table 5.

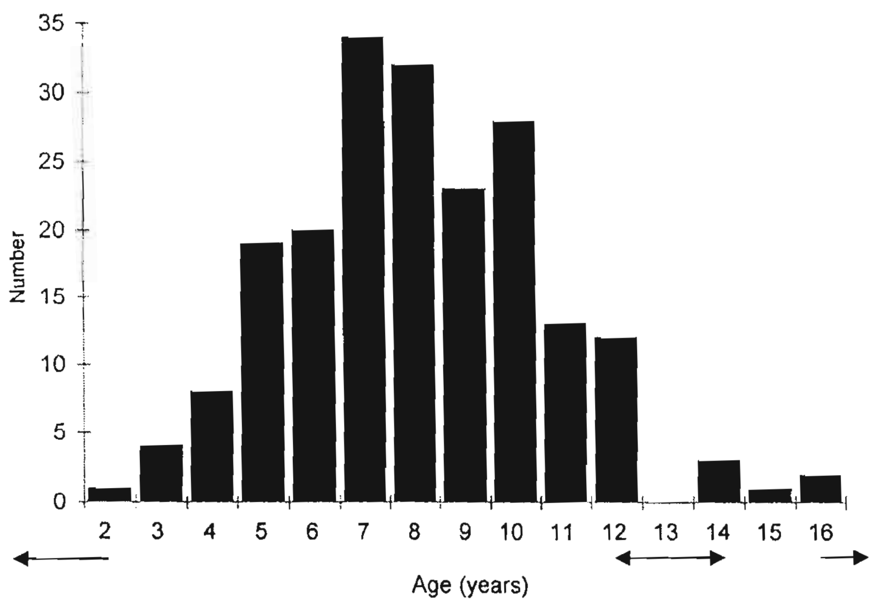


FIGURE 2.—Age frequency of 200 lower Mississippi River shovelnose sturgeon captured between 15 October 1995 and 12 March 1997.

Year of Opening 1994 1983 1979

The pallid sturgeon age distribution table (Table 6) 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 7) than the 1997, 1994, and 1983 openings and did not extend into the spring spawning season (Table 4) the Service believes 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 6). 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 jeopardize the pallid sturgeon.

Table 6.

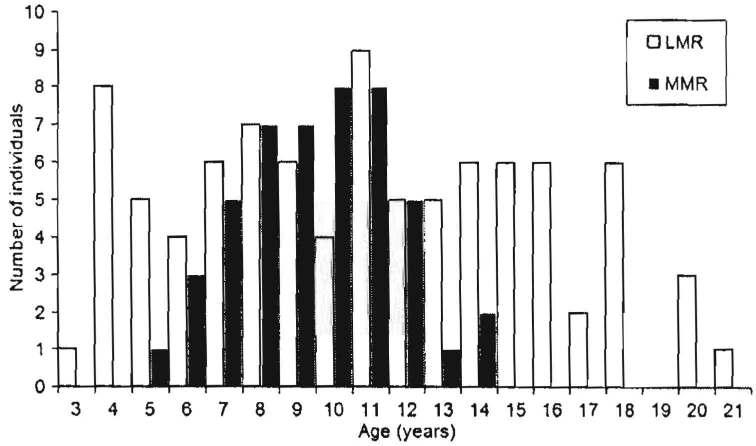
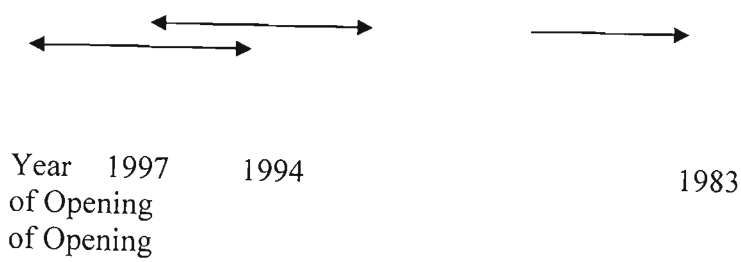


Fig. 1. Age distribution of pallid sturgeon in the lower Mississippi River (LMR) and middle Mississippi River (MMR)


Year
of Opening
of Opening
1997
1994
1983

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).

Examination of cohort sizes that would have been exposed to the Bonnet Carre Diversion coupled with the relatively few recaptures of tagged pallid sturgeon (indicative of a relatively large population) and the increased number of all ages 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 jeopardize the pallid sturgeon.

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 "taken" by the structures operation. There are several hypotheses on possible sturgeon reactions to entrainment that must be considered to determine levels of take: only sturgeon located near the structure during its opening will be entrained (i.e., no increase in sturgeon entrained because of active avoidance); sturgeon 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 sturgeon were entrained passively or actively during down-river migration. It is likely that the reaction to a diversion would vary with the life stage of the sturgeon, and actual adverse impacts may be due to a combination of any of the above hypotheses.

This biological opinion is based on direct and indirect effects that are anticipated to pallid sturgeon as a result of restoring Mississippi River flows via a water diversion. It is anticipated that approximately 23 pallid sturgeon per year (1150 over the project life of 50 years) will be lost from the population via entrainment. 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. 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 current freshwater diversions and the proposed Medium Diversion at White Ditch, and the cumulative effects, it is the Service's biological opinion that construction and subsequent operation of a new freshwater diversion at White Ditch between RM 64 and 59 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 entrapment behind the structure) and harassment will result from the operation of the Medium Diversion at White Ditch. It includes mortality associated with entrapment behind the structure.

The Service estimated incidental loss (by death or serious injury) associated with entrapment behind the structure of 23 pallid sturgeon adults per year or 1150 adults over the project life of 50 years. In other words, 1150 fish will be harassed via entrainment with some proportion of those fish becoming injured and dying; as a result these fish and the others will be effectively removed from the Lower Mississippi River population. 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. Larval and juvenile pallid sturgeon have been collected in trawls and it may be possible at the completion of ERDC's sampling to estimate take by calculating the number of fish collected per unit of water volume passing through the trawls.

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 medium diversion at White Ditch.

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. Research possible designs of fish bypass or passage systems that may be incorporated in future projects or retrofitted into the current or existing projects should take.

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.

James F. Boggs
Supervisor
Louisiana Field Office

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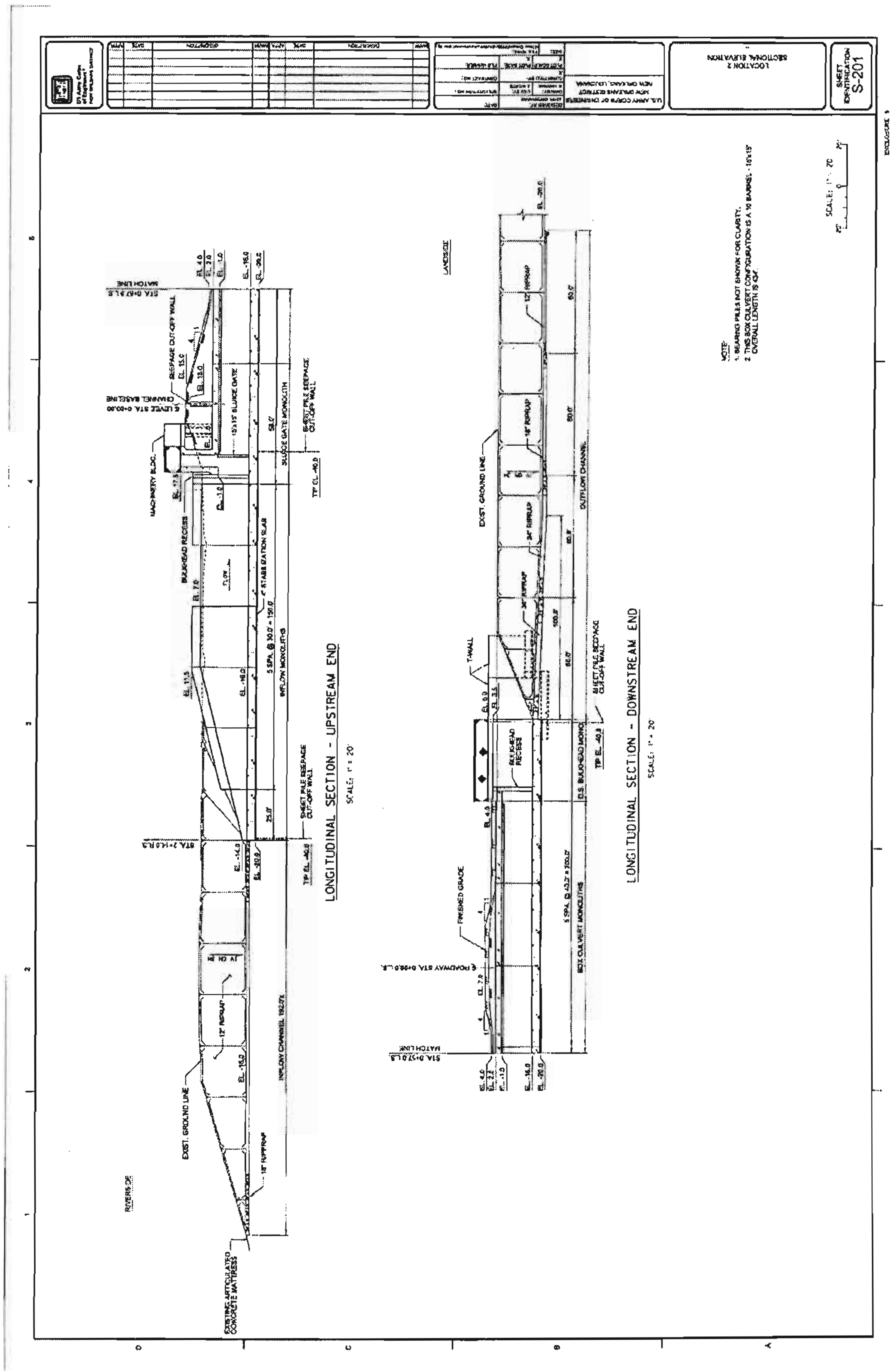
APPENDIX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MACHINERY BLDG.
BULKHEAD RECESS
SLUICE GATE MONOLITH
INFLOW CHANNEL
OUTFLOW CHANNEL
BOX CULVERT MONOLITHS
FINISHED GRADE
T-WALL
EXISTING ARTICULATED CONCRETE MATTRESS
U.S. ARMY CORPS OF ENGINEERS
NEW ORLEANS DISTRICT
NEW ORLEANS, LOUISIANA
LOCATION 2
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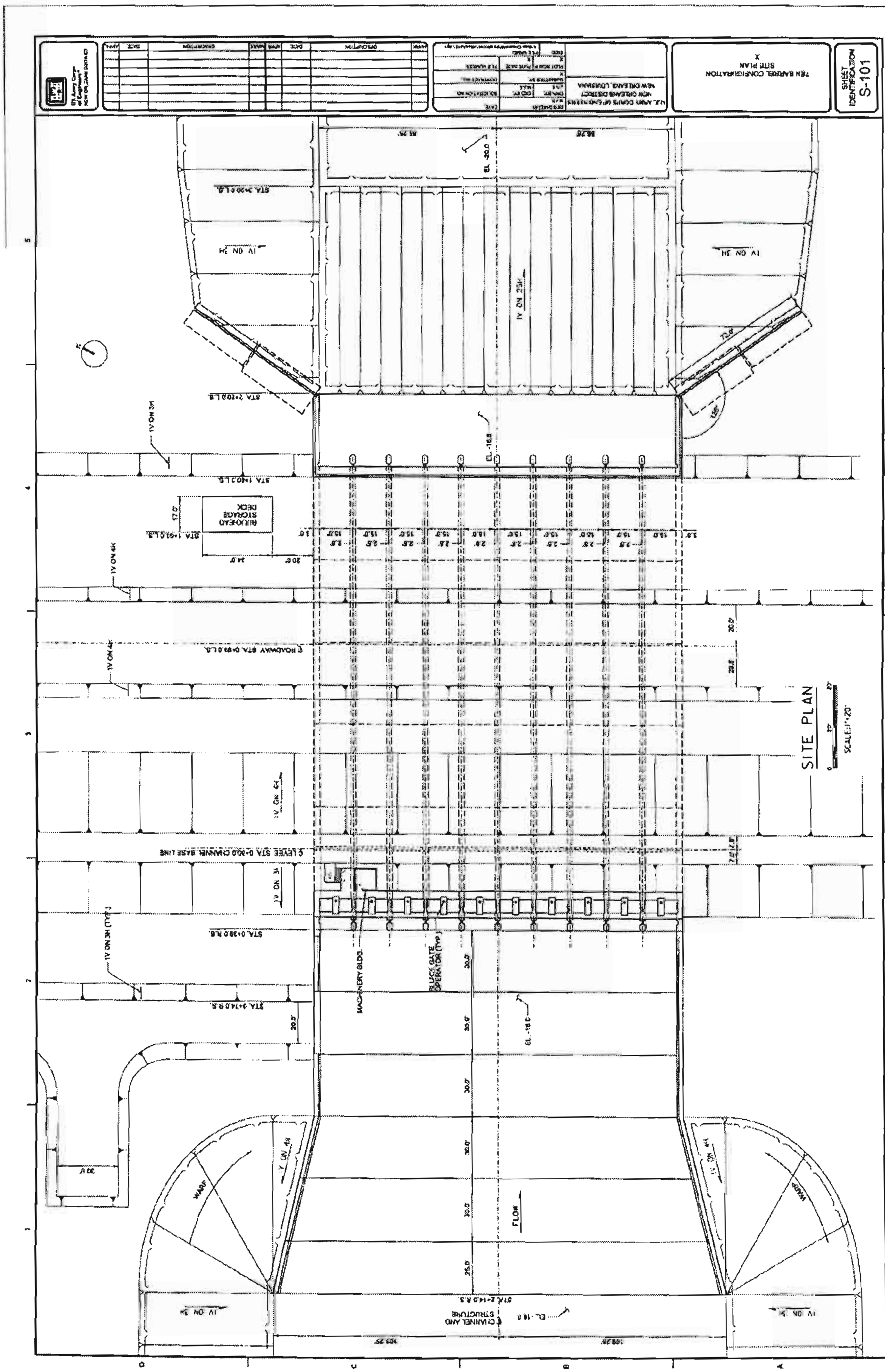
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SITE PLAN
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Appendix A-4

Formal Section 7 Consultation Receipt
U.S. Fish and Wildlife Service

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 15, 2010, receipt of your agency's July 15, 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, Medium Diversion at White Ditch, project. In the May 14, 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 1, 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,

for James F. Boggs
Supervisor
Louisiana Field Office

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